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A RATIONAL BASIS FOR ANGLO-AMERICAN CO-OPERATION.

By Sir Nathaniel Barnaby, K. C. B.

THE chairman of the senate committee on foreign relations, speaking recently at St. Paul, said: "It is manifest that the United States will be a great naval and military power, and certain exponents of European opinion, who until recently spoke with a condescending assumption of authority of intervening in the present contest, have abated the hauteur of their expressions." In the course of the same address he is reported to have referred to the relations between America and England in terms which have been received in England with great pleasure. "Unpleasant relations," he said, "have existed between the United States and England for years, due to the traditional aversion, aggravated by certain events in the civil war and by many minor irritating controversies, the worst feature of which is the fact that few of them have ever been settled. But through all this it has been felt by the people of both countries that a tie binds them together, however much they may irritate each other by straining it. It is very plain that a change of sentiment or expression, and of the general contour of the relations of the two nations, has taken place. The conviction, heretofore only imperfectly felt and only partially, infrequently, and fitfully acknowledged, is now clearly operative, and is openly and spontaneously expressed,—that one hundred and twenty-five millions of English-speaking people, who have established representative government and secured personal liberty in all parts of the world, whose civilisation is still progressive, who have taken no step backward in an expansion of influence and empire without comparison in history, are amicably approaching each other under the pressure of a great human evolution."

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The most obvious advantage of such an approach is the promise which it gives that misunderstandings which may arise in the future shall be amicably settled. The treaty of arbitration proposed by Lord Salisbury and not yet accepted by the United States was a possible way of taking advantage of the feeling expressed by Mr. Davis in the terms which have been quoted. The contracting bond was perhaps premature. Kindly feelings exist on both sides of the Atlantic, but they perhaps need strengthening before anything like a permanent treaty can be made. We may hope that the sentiment itself, without a bond, is strong enough to prevent diplomatists from blundering into conflict, and that war between the two countries is no longer possible under any fancied provocation. But it will be well to distrust diplomacy in the matter, and to trust rather to the methods by which two kindred souls approach and enter into life long alliance.

In such cases the best traditions of our race point first to the necessity for a conviction that there is a noble life-work in which the two may usefully and happily join. No less powerful conviction would have satisfied our Puritan ancestors when they made their domestic alliances. The fact that there is no such common life-work possible to the contracting parties explains the misery and emptiness of many of the marriages of to-day, and is of ill augury for some much-vaunted modern political alliances.

Mr. Davis refers to some of the ideals in which the English-speaking people are at one. In a striking letter to the London *Times* of July 29, Mr. Benjamin Kidd refers to another. The distinguished author of "Social Evolution," speaking of trade with the tropics (including in that term the belt of territory within the parallels of 30° north and south of the equator), says that the combined trade of the two leading sections of the English-speaking world with the tropics amounts to some forty-four per cent. of their total trade with the rest of the world.

In 1895 the trade of the United States with the tropics reached, in English currency, some 70,000,000 sterling, while that of the United Kingdom is estimated at 138,000,000 sterling. He goes on to say: "In the immense regions concerned there are embraced some of the richest territories on the earth's surface. But they are territories as yet, for the greater part practically undeveloped. Yet it must be remembered that it is in an interchange of commodities between these regions and those at present occupied by the European peoples that it is possible to have permanently operative, on the largest scale upon which it could be made operative in the world, the great natural principle underlying all trade—*i.e.*, that the interchange of products between peoples and regions possessing different natural capacities

tends to be mutually advantageous. No serious attempt, at least no attempt of the kind which the importance of the subject appears to deserve, has so far been made to set forth the principles which should underlie our future relations with the tropical regions of the world. Over a considerable proportion of these regions at present we have existing a state either of anarchy or of primitive savagery, pure and simple, in which no attempt is made, or can be made, to develop the natural resources lying ready to hand. Over a portion of the remainder European powers hold control. In some of these cases this control is maintained on principles beyond the exercise of which the advanced peoples have certainly moved, and upon the practice of which no scheme of policy towards these regions could ever again be successfully submitted for public approval among ourselves. In England, at the present time, the feeling is probably instinctive that our relations with the tropics are likely to be extended rather than restricted in the near future. But, although we appear to be dimly conscious that we are living in a period of new and higher standards of national duty in such relations, although we even at times appear to catch sight of the high and important responsibility which the conscientious discharge of a national duty in these relations may involve in the period upon which we are entering, nowhere is there to be found any whole-hearted and consistent attempt either to justify the political relations which already exist, or to define the principles of any relations which ought to exist in the future."

Representative governments; personal liberty, civil and religious; the supremacy of constitutional and common law, and the subordination of all military tribunals thereto; the diminution of the area of national rivalries and the absolute exclusion of such rivalries from among the English-speaking people; the attempt to develop and promote the interchange of products between peoples and regions possessing different natural capacities,—in these things lie the worthy objects of our common life-work.

Nor is there anything in these ideals which can injure our neighbours. British diplomacy for the last fifty years, in relation to Russia, has been conducted in a spirit which would be speedily changed under the rule of such principles as have been set forth here. It would be seen that every new opening for the commerce of Russia will tend to bring her into line with us, and every ship which she builds will be an additional reason to her for keeping the peace with a more powerful maritime people. Even to-day it must be sorrowfully confessed that the British foreign office moves in the fetters of a bad past.

When the ideals of two parties are seen to be alike, and the oppor-

tunity for noble work in common is realised, another stage is entered on; the lover brings gifts. In this case neither party has any gift to offer of which the other stands in any need. The gifts can be only expressions of good will and confidence. It is the desire to point out how this may be done which must justify this article.

There is, first, the gift of joint nationalisation for the seamen, so that every enrolled seaman may, for the time being, claim the nationality of the flag under which he may be serving, whether it be the British Ensign or the Stars and Stripes.

According to the British foreign enlistment act of 1870, America is a foreign State; the act reads as follows:

> If any person, without the licence of Her Majesty, being a British subject, within or without Her Majesty's dominions, accepts, or agrees to accept, any commission or engagement in the military or naval service of any foreign State at war with any foreign State at peace with Her Majesty, and in this act referred to as a friendly State, or whether a British subject or not within Her Majesty's dominions, induces any other person to accept, or agree to accept, any commission or engagement in the military or naval service of any such foreign State as aforesaid, he shall be guilty of an offence against this act, and shall be punishable by fine and imprisonment, or either of such punishments, at the discretion of the court before which the offender is convicted.
>
> If any person, without the licence of Her Majesty, being a British subject, quits, or goes on board, any ship with a view of quitting Her Majesty's dominions, with intent to accept any commission or engagements in the military or naval service of any foreign State at war with a friendly State, or, whether a British subject or not, within Her Majesty's dominions, induces any other person to quit, or to go on board, any ship with a view of quitting Her Majesty's dominions with the like intent, he shall be guilty of an offence against this act, and shall be punishable by fine and imprisonment, or either of such punishments, at the discretion of the court before which the offender is convicted.
>
> If any person induces any other person to quit Her Majesty's dominions, or to embark on any ship within Her Majesty's dominions, under a misrepresentation or false representation of the service in which such person is to be engaged, with the intent, or in order, that such person may accept, or agree to accept, any commission or engagement in the military or naval service of any foreign State at war with a friendly State, he shall be guilty of an offence against this act, and shall be punishable by fine and imprisonment, or either of such punishments, at the discretion of the court before which the offender is convicted."

The gift offered to the United States should be the right to claim every British seaman or officer under her flag as an American citizen, made so by the flag during his period of service.

Next she should be invited to make an exchange of gifts. Citizens of the United States serving under the British flag should also be held to have changed their nationality during such period of service. Acts which would be treasonable if committed by British seamen under the British flag should be regarded as equally treasonable when committed by an American under that flag. The same rule should apply to Britishers serving under the Stars and Stripes.

The time would come when honours from the crown would be won by Americans serving under the British ensign. However high those honours might be, it is to be hoped they would be offered gladly and worn with pride.

America should be invited also to join Great Britain in establishing, on the coasts, State elementary nautical free schools for giving two years' training at the public expense to lads living in the neighbourhood of the schools and desiring such training, the lads to be perfectly free, during their training or after its completion, to engage in ships of any nationality, or otherwise to dispose of themselves. Their speech would naturally favour their entering under the American flag or our own, if they decided to follow the sea. If we thus gave each other our sons, we should, as Mr. Gladstone said, corroborate the bonds which unite us.

England moves with decision in the expenditure of money upon ships, but she is strangely unready to interfere with the rights of the ship-owners to engage foreign seamen to serve under her flag. They may engage men of another tongue and without nautical training.

She is now considering the possibility of enrolling colonial seamen in her naval reserve. The 75,000 men engaged in deep-sea and inland fishing in Canada, for example, have never been a recruiting material for the naval reserve. A clause has been added to the merchant shipping bill now under consideration, designed to induce ship-owners to enter apprentices, offering to them in return a reduction in the light dues paid by any ship which carries boy sailors between the ages of fifteen and nineteen, such boys being enrolled, and agreeing to serve, in the royal naval reserve.

It looks as if the ship-owners would decline to co-operate in such a scheme. But it is certain that they would gladly engage English-speaking lads who had had one or two years' training in boat work, in the use of fire-arms and of nautical instruments, and who came with certificates of character from Liverpool, from New York, or from a British colony.

What is to prevent the establishment of such relations between the United States and Great Britain? Some English people regard the Irish influence in America as being hopelessly hostile. Such a feeling may well exist where distrust of the Irish people at home has warped the judgment. The English Home Rule party is silent at present. It is idle, say its leaders, to attempt to place the question in the front again, until the Liberal party has become united on a common platform from which that plank shall for a time have been excluded. But justice to Ireland will be a war-cry yet in the United Liberal party, and the sympathy and co-operation of the United

States, on some such lines as have been indicated, would put new life into those who love the Irish people and who would bury all rancour and distrust between British and Irish. The English Home Rulers wish for no better fellow-citizens than the educated, disciplined Irishman. They point with pride to the Irish constabulary, recruited in the most troublesome districts of that country, and they set before their sons as the noblest type of man the Irishman John Nicholson, who, at the age of thirty-five, ended his noble life while wresting Delhi from the rebel Sepoys, and who will be known to all generations as the great captain and hero of that heroic time.

It is not easy for the American to fit his tongue to the glibness of speech of the modern Britisher, and his continued belief in the necessity for pronouncing certain letters soon betrays him when he attempts to do it. He is almost as easily detected in his speech as is our English-speaking German cousin. But, apart from peculiarities in accent, which are stubborn, every national distinction seems to vanish in the 'tween decks of a man-of-war, where British, Americans, and Germans meet as comrades or friends. The writer was once in the ward room of a large German ship of war, in which the officers of two ships were assembled. One of these ships had just been accidentally sunk by her consort, and both ships' companies were in one ship. In this assemblage of officers two things impressed him. One was how homely the ward room seemed to one familiar only with British surroundings and not speaking the language of his hosts. The other was that nowhere had he ever seen such an assembly of handsome, well-built men. Many years afterwards he met, in Washington, a large party of senior officers of the United States navy. These were men hardened by time and weather; their youthful bloom was gone; and they were just, man for man, the counterparts of flag officers familiar to him at home. He could have fancied himself at a naval club dinner in London celebrating some British naval victory. There is a nationality of the salt seas which makes its mark upon its children. No racial differences among the citizens of the United States would be likely to interfere in the good work of welding together the sons of these islands and the children of the western continent in the warships of the two kindred peoples.

And, when these bonds have been strengthened by the recognition of our common ideals and of the work which lies before us; when mutual courtesies have brought us heart to heart, especially upon the seas,—what then? We may sketch our own pictures of the future. The lover of these beautiful islands—the jewels set on the breast of the old continent—sees in them the common ancestral home of the latest, and perhaps the final, Masters of the Sea.

THE INDUSTRIAL INTERESTS OF THE UNITED STATES IN THE FAR EAST.

By Wharton Barker.

THE extension of occidental influence and commerce through the orient is the most striking and significant feature of an era which is characterized, above all, by international industrial competition and the struggle for new fields for industrial expansion. The sudden, and even dramatic, advance of the United States to its appropriate place in this movement, makes it vitally important to comprehend the character of the undertaking and the factors and influences which are to be considered. In discussing the problems of the Far East, I shall confine myself, as far as possible, to China, because the Chinese must play the leading part in the coming drama, and because I have a knowledge of the purposes of some of the great men who must act for China, the men who know of the latent wealth of the country and appreciate what development on American and European lines means.

I was asked in 1887 by Chang Yen Hoon, then Chinese minister to the United States, now vice-president of the Tsungli Yamen (foreign office), to consider proposals to undertake large enterprises in China in coöperation with Chinese selected by the imperial Chinese government. Of course I gave proper consideration to the proposals. I sent my representatives to China in the summer of 1887, and opened important negotiations at Tientsin, which were carried to the second stage at Philadelphia in the autumn of that year by Ma Kiet Chang, the special envoy of the Viceroy Li Hung Chang, sent to America to confer with me,—negotiations that covered a period of three months. A comprehensive plan for the development of China was agreed upon, of course subject to the approval of the imperial government at Peking. I hoped, and almost believed, that the greatest industrial and commercial undertaking of modern times was about to be put in operation under my general direction. The knowledge of the scope of the undertaking soon reached both political and commercial leaders in London, probably through Sir Robert Hart, the inspector-general of customs at Peking. At once every kind of pressure, public and private, was brought at Peking by Great Britain to prevent the ratification of what were known as the American concessions; for it was well known that, if the great undertaking was carried out as planned, the Chinese in a few years would reach a development that would place them in an independent position, and make American influence paramount. Great Britain wanted neither.

The British opposition would not, in my judgment, have prevented the ratification of the concessions, but for the bad impression made upon Chinese statesmen by the passage of the Chinese exclusion act by congress in 1888, and the belief that America was not keeping faith with China. The plans then halted have never been abandoned. I have kept up a correspondence with leading men at Peking, Tientsin, and Shanghai, and, upon invitation of very high Chinese officials, I went to China in the autumn of 1895 and met Li Hung Chang, Chang Yen Hoon, Sheng Taotai, now director-general of railroads, and other able and very influential men. I found at Shanghai and Peking representatives of several American, British, French, Dutch, and German syndicates, hard at work endeavoring to get concessions that would, in my judgment, have been destructive to Chinese autonomy, but, of course, most advantageous to foreign interests. The Russians were at work through the imperial Russian government, and had the inside track. The influence of Great Britain at Peking, once very great, had been lost, because the British government supported Japan and opposed China in the war of 1894–1895. Reports are made from time to time that this and that syndicate has received a valuable concession, but so far only Russians have succeeded in getting any substantial footing in China. Great Britain and Russia are at swords' points over the Chinese question, and Germany and France are probably in accord with Russia. Americans want to take part in the expected development, but are as yet ignorant of China, of Chinese character, and of the only way in which large undertakings can be carried on successfully in that country. Some Americans think the way is open for great undertakings not only in China, but also in other countries of the Far East, through retention of the Philippines by the United States, and therefore urge the taking up of great political responsibilities, of burdens that cannot be measured now.

In my judgment the Chinese empire cannot be broken up at this time by European nations, because the four great powers—Great Britain, Russia, France, and Germany—will not be able to agree upon the share of each in the proposed dismemberment, and no one of them can gain a permanent foothold in China without the consent of the others, not even through a great and costly war. The government of China may pass from the present Manchu dynasty to a Chinese dynasty, the result of some uprising of the people, or one or another of the European powers may for a time hold China in some kind of vassalage, but the great Chinese people cannot be broken up, nor can their industrial power be limited or controlled, by any outside influence. When Americans are ready to be honest in their dealings in China; when they are ready to work in coöperation with Chinese; when

they are ready to invest large sums of their own money in China in coöperation with and through Chinese,—they can do great things in that country, bring to China permanent benefit, work to their own credit, and at the same time earn very large profits. The time has come for Americans to begin work in China, but they must coöperate with Chinese, they must be fair to the Chinese, to ensure success. They can do nothing on the lines on which British, Russians, Germans, and French have operated. Force cannot fail to make the Chinese stubborn and suspicious, while proper proposals of association and coöperation will give them confidence, and make them more than willing to have American assistance in the development of their great country. No small plan of operations will work now in China. Fifty syndicates, with capital of $1,000,000 each, working on independent lines cannot succeed, but one properly-managed American Development Company (if I may call it so), with an actual capital of $20,000,000 or $25,000,000, can do at once a most profitable business, for Chinese patience and industry, supported by large capital and directed by those who understand what they undertake to do and who appreciate the capabilities of the Chinese, will overcome the opposition to change that now exists. I believe the time of the reactionaries has almost passed, and that an impulse has been given that, when China awakens, will develop the cotton, woolen, silk, and other textile industries, and start the mining of coal and all kinds of metals and the manufacture of iron and steel, on a great scale not now thought possible. The building of great systems of railroads and canals—more canals than railroads—will shortly be undertaken.

The Mandarins no doubt will be able, for years to come, to prevent foreigners from getting concessions for any of these works, so long as the concessions asked for carry profit only to the foreign capitalists and are sought only on a basis of unfair discrimination in favor of foreigners and against Chinese. But the Mandarins will be powerless against the kind of foreign coöperation I propose, for great men, such as Viceroy Chang Chi Tong and Weng Tung Ho (who has now almost unlimited power at Peking), will surely coöperate, men who have a great hold upon the masses of the people, and upon the rich and able merchant class, as well as upon the ruling dynasty, because of their real ability and an established reputation for probity that no enemy has been able to break down. These men and their associates are not in accord with Viceroy Li Hung Chang and his associates, but they must coöperate with him because of his preëminent ability and perception. None of these men should be judged by European or American standards; they are trammelled by their training and surroundings. There is scarcely a need that these

men have not seen and planned to supply, nor an enterprise they would not support on the basis which I outline.

China, beyond a doubt, is a country of unsurpassed natural resources. It is also unquestioned that those resources remain undeveloped. There are anthracite coal fields more extensive and apparently richer than the anthracite fields of Pennsylvania; there are bituminous fields that can be paralleled, if at all, only by our own; there are rich iron deposits in close proximity to the coal such as promise the production of iron and steel, for China's development, at prices at which American and British and German iron-masters cannot hope to lay down iron and steel in China; there is in the immense Yang-Tse valley, a valley paralleled by the Mississippi but running in an opposite direction, between degrees of latitude rather than longitude, an area suited to cotton culture that rivals, if it does not surpass, our own; and withal a country teeming with a laborious population, a population as bidable as it is industrious, insuring a development that will be appalling to the rest of the world, the moment the path is paved for the entrance of Americans and Europeans to give direction. And the Americans and Europeans who thus expatriate themselves will doubtless have opportunities to amass great fortunes. They will do so, however, by developing, not trade with China, but within China.

China is a country of unsurpassed productive capacity, but not, at present, of great consumptive capacity. And that consumptive capacity cannot grow, until her productive capacity grows, save so far as Europeans and Americans, anticipating the future, may loan capital to China, giving steel rails and locomotives and machinery in return for bonds, or so far as Chinese with hoarded gold and silver, also anticipating the future, may part with such metal and spend it to bring productive capital from abroad. But such importation of material can continue only for a time, for China has within herself the means to develop herself,—all save that energy possessed of the western nations and needed to give direction to the immeasurable energies of her people. And that energy she must import. She will have occasion, in her development, to import but little more.

Of course, as the productive capacity of her people increases, so will their consumptive capacity. As her people produce more wealth, they will consume more wealth; but there is no reason to believe that they will buy more of foreign peoples. They will, indeed, consume more goods, but they will be in a position to fill their own wants. This consumptive capacity will increase only with their productive capacity, and there is every reason to believe that they can and will make everything they want and at less cost than that at which other peoples can make and deliver such goods to them. Conse-

quently they will buy of themselves, and not for long, or to any very great extent, purchase of others.

So we need not look to China for a great market for our products. When the development of China comes, whether as an empire, or as a divided people under the tutelage of others, Chinamen will supply their own markets. Chinese rail mills will roll the rails for Chinese railroads, Chinese manufactories will make the cloth to clothe Chinese backs. In other words, China will be no more dependent than she is now. She will be self-sustaining, capable of making at low cost practically all that her people consume,—an agricultural and mining and manufacturing country, not an importing country. The prime question for the people of the rest of the world will not be whether they may manufacture to clothe the backs of the Chinese, but whether the awakened Chinese may not clothe the backs of others.

The transportation question for China would be met more by the development of the canals than by the building of railroads. This is because the water-ways, natural and artificial, are already very numerous, and can be utilized as in no other country by the substitution for man-power, now largely employed, of steam, electric, or compressed-air motors. Twelve thousand miles of water-ways are now open in the Yang-Tse-Kiang basin, and an additional mileage of ten thousand miles of canal can be opened at a cost small in comparison with that of building railroads. The problems for the engineer are not serious. I do not believe that any great trunk-line of railroad in the populous parts of China will be constructed by foreign syndicates, for the Chinese have been awakened, by the grants already made to the Russian government, to the dangers to China from foreign control of the public highways. Foreign engineers will be employed to build railroads and canals, and at the start foreign general managers and traffic agents will be placed in charge; but soon all will be replaced by Chinese. These lines of railroads and canals will, if necessary, be built with associated Chinese capital, or with money taken from imperial and provincial treasuries. There is plenty of hoarded money in China, which its owners will invest in railroads, canals, steamboats, steamships, factories, and mines, when satisfied that their investment will be safe from the attacks of the official class, safe from unfair taxation and from blackmail. These men will be only too glad to invest their capital along with that of foreigners who will be just to their Chinese partners. This is proven by the Chinese in the Malay Peninsula and in Java, where they are large and most willing sharers in railroad and other corporate undertakings.

As I have said, the mineral wealth of China is great. I have seen reports of competent foreign engineers in the employ of the Chinese

that leave no doubt of this. Gold is found in many parts of the country, and a large gold-yield from China has been prevented only because gold-washing and gold-crushing for private account are forbidden. I brought home from the province of Shangtung a fair sample, taken from a vein from 2½ to 4 inches wide that yielded $226,-165 per ton; I believe no other so valuable mine has been found. This sample was assayed in Philadelphia. A way must be found, and no doubt will soon be found, to remove the existing bar to gold mining.

Investment in production, for export, of Chinese silk, cotton, and woolen fabrics will be found profitable, so long as the difference of exchange that exists now continues,—a difference due to the divergence between silver and gold.

There is a great opportunity for Americans (greater at this time for Americans than for British, Russians, Germans, Belgians, or French) to do business in China, not by following the plans suggested by the many syndicates now trying to get "Chinese concessions," but by the plan of uniting Americans with Chinese upon a scale of operations that will enable them to take up great undertakings and carry them until it is demonstrated that, well managed, they will return fair profits year in and year out. I am confident that in due time the Chinese will buy these developed enterprises, and release the original capital for new ventures. The field is almost without limit, but it cannot be occupied by those who employ the old and oft rejected methods so well known to the Chinese,—the methods of the ordinary promoter who has made himself odious all over the world. There are very few men in America who have the knowledge of the conditions that exist in China, the requisite relations with Chinese, and the capital needed for the successful doing of the business. There must be found a way to unite these requisites—knowledge of China, confidence of the Chinese and capital—before successful business can be carried on in China by Americans. I suggest the establishment of an American joint-stock company for doing business of all kinds within the borders of China, with an actual paid-up capital of at least $20,000,000. At the head of this corporation must be placed an American who has the confidence of both Chinese officials and merchants, a man who understands oriental as well as European and American methods. Of course the chief office of this corporation must be at Shanghai or Peking, not in America. I do not believe that such an American corporation would meet the opposition of either British or Russians, and I am sure that no opposition of Germans, French, or Belgians could hinder it in its work. I do not now go into detail, but some time I may present to the American investing public a plan most advantageous to Americans and to Chinese.

THE LATEST IMPROVEMENTS IN THE FRENCH LIGHTHOUSE SYSTEM.

By Jacques Boyer.

OF late it has been said frequently that the history of medicine may be divided into two periods,—medicine before Pasteur, and medicine since Pasteur. The science of lighthouse-construction has experienced a like renewal. It was in its infancy before the time of Fresnel, while, since his memorable discovery of the echelon system of lenses, it has continually advanced towards perfection, or, rather, it has been reconstructed from the very foundations. It is not my intention to exhibit the successive developments which the subject has experienced since the time of its revival, as this would greatly exceed the present limits of space. I rather desire to acquaint the readers of THE ENGINEERING MAGAZINE with the existing state of lighthouse practice in France, and, above all, to bring into prominence the latest ideas in this branch of applied science. The subject is especially noteworthy in view of the completion of the lighthouse at Penmarch, where a dangerous point on the Breton coast is indicated by the most powerful light in the world.

Before entering upon details, a few words as to the purpose of this article.

In the first place, it is assumed that the reader knows something of the various characters given to lights in order that their identity may be recognized. I may remind him, however, that in France the coast lights are divided into five categories: fixed lights, lights of occultation (occulted lights), colored lights, flashing lights, and mixed lights resulting from various combinations of the preceding. This being understood, we are in a position to begin the study of the "lightning-flash" system—the perfection of which seems destined to mark an important advance in the evolution of the illumination of coasts—and its application to the various kinds of French lighthouses. We shall then conclude by describing the light-ships and luminous buoys, without forgetting to speak of the hyperradiant light of Cape d'Antifer.

The most important modern innovation is that of the so-called "lightning-flash" lights, which enable the maximum lighting efficiency to be realized. This consists in the reduction of the duration of the flashes to the exact time necessary to permit the integral perception of their luminous intensity. The optical system is composed

of a small number of lenses, and their rotation is effected in five, ten, or twenty seconds. In this way the loss of light is reduced, and, in consequence, the power of the lighthouse is increased without any increase in cost. These lightning-flash lights are divided into two classes,—those with uniform flashes every five seconds, and those with grouped flashes, in which the groups succeed each other at intervals of ten, fifteen, or twenty seconds, according as there are two, three, or four flashes in each group. Fig. 1 represents in plan the distribution of the light in a lightning-flash system with regular flashes, and Fig. 2 a lightning-flash system with flashes grouped by twos.

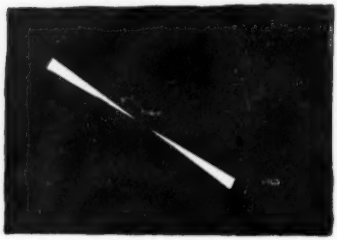


FIG. 1. LIGHTNING FLASH WITH REGULAR FLASHES EVERY FIVE SECONDS.

According to the investigations of Plateau, of Helmholtz, and, above all, of Charpentier, the time required for the integral perception is shorter as the luminous intensity of the source of light is stronger. It varies according to a law which has not yet been exactly determined, and concerning which further investigations are unnecessary, so far as lighthouses are concerned. The important practical point to be determined is *the duration of the integral perception of the light at its minimum perceptible intensity*, or, in other words, the time required for an observer to perceive, as a whole, the light of the lighthouse at the limit of its range. Now, according to the above law, this corresponds, at a maximum, to the duration of the flash, which, being sufficient at the limit of range, must, *a fortiori*, at less distances result in greater brilliancy. Hence the luminous range of a lightning-flash system is the same as that of a fixed light of equal intensity. Now we may discuss the relative determinations of the maximum duration of the flash.

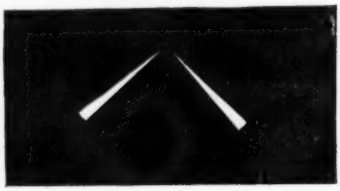


FIG. 2. LIGHTNING FLASH, FLASHES GROUPED BY TWOS.

The experiments of Charpentier upon the minimum period of perceptible intensity have shown that it is comprised beween $\frac{1}{8}$ and $\frac{1}{15}$ of a second for white light, and that it varies according to the surrounding light, and according to the constitution and adaptation of the eye. M.

Charles Henry, the director of the physiological laboratory at the Sorbonne, endeavored to avoid any external cause of error by determining this minimum, after having remained in darkness for five hours, and his results showed a notable difference from those obtained by the engineers of the central administration of light-houses at Paris. While these latter have been evaluated to the hundred-millionth of a carcel-metre, — the minimum intensity, at which the light ceased to be perceptible,* has been found by M. Henry to be only one-third of this value.

In practice, however, many factors unite to render the minimum intensity much greater. The observer is inconvenienced by the movements of the ship, and the surrounding light is much stronger than that in a laboratory. It is therefore necessary to give to the flashes a shorter duration than that which the experiments of M. Charpentier seem to warrant. We may safely use a value of $\frac{1}{10}$ of a second. This is the duration which has been adopted for the electric lights of Creach (Ile d'Ouessant), Belle-Isle, and Barfleur. Experiments upon their visibility, made nightly from 1888 to 1892, failed to reveal any anomaly, and there has been no criticism on the part of the navigators. In fact, it has been shown that sailors are unable to detect any difference between electric flashes of $\frac{1}{10}$ of a second and those of three times that duration. This value, therefore, has stood the test of experience, and may be considered to have the sanction of usage.

On the other hand, since the luminous rays impress the navigator only for a very brief period, the eclipse, if there is but a single lens, must last almost through one revolution. This renders it necessary to give the apparatus a *very high rotative speed*, in order that the eclipse may be brief. We are limited to an average duration of five seconds. For a system with a single lens this would then be the time of a single revolution; for two lenses a revolution in ten seconds would suffice, or a revolution in twenty seconds for four lenses.

Let us now consider the case of a single-lens system, occupying in plan a half-circle, the other half being a reflector; and let us seek the conditions which must be fulfilled in order to obtain the maximum effect. If we suppose the entire horizon of 360° to be covered in five seconds, the angle included in one second will be 72°, and in one-tenth of a second the bundle of rays will extend over 7.2°. That is to say, with a single-lens apparatus, revolving once in five seconds, the eye of the observer will receive an impression during one-tenth of a second if the bundle of rays includes an angle of 7.2°.

* That is to say, this intensity is equal to the light of one-one-hundreth part of a carcel burner seen at a distance of one kilometre through a perfectly transparent atmosphere. The carcel, or carcel burner, is about equal to ten English spermaceti candles.

By concentrating the entire amount of light into this reduced angle, the intensity of the illumination and, in consequence, *the range of the lighthouse*, will be augmented, the source of light remaining unchanged. Now, in order to produce a bundle of rays having this horizontal divergence of 7.2°, the lens system must have a focal distance which shall cause the extreme rays to subtend this angle. An elementary geometrical calculation shows that the horizontal divergence of points placed at a distance l from the focus for a flame of the diameter d, is given by the equation: $d = \frac{7.2^\circ}{360^\circ} \times 2\pi l = \frac{1}{8} l$, or $l = 8d$. When the apparatus has a two-lens system, since the velocity of revolution is one-half as great, the diameter of the flame is reduced one-half, and then $l = 16d$, while for an apparatus with a four-lens system $l = 32d$.

For lightning flash lights to be used with mineral oil the most available combination is that of a single-lens system furnished with a spherical reflector of silvered glass. The lens utilizes one-half of the light emitted by the flame, and one-third of the balance is returned by the reflector. The hemispherical arrangement not only is the cheapest, but also possesses the advantage of permitting free access to the lamp by the keeper. The principal objection to it is that it requires a larger flame than the other forms. For this reason it is not used for lighthouses above the third order.* Under these conditions the power of a flash-light of this order is about double that of the old-style light of the first order formerly used on the coasts of France.

Flash-lights of the two-lens system, although utilizing only one-half the entire light for each flash, may be applied to lights of every order, even including the first, because they involve the use of the smaller flames only.

Early in 1892 there was erected on Point Senétose, in Corsica, a light of the fourth order, with a four-lens system, and in 1893 the old fixed light at Titan was replaced by a flash-light of the third order. Finally, in 1895, the light at Hourtin was installed. Its optical system (Fig. 4) is contained in a lantern 3.5 metres in diameter, placed upon a square tower (Fig. 4). It is supported by a cast-iron platform, which holds the vertical spindle upon which it rotates. The two reservoirs of oil from which the burner is fed are placed in the upper portion. A regulating device placed in the feeding tube maintains a constant level of oil at the burner, whatever the height may be

* The French administration of lighthouses divides the lights into seven orders, according to the focal distance of their optical systems in millimetres. The arrangement is as follows: First order, om, 920 mm.; second order, om, 700 mm.; third order, om, 500 mm.; fourth order, om, 250 mm.; fifth order, om, 187 mm.; sixth order, om, 150 mm.; seventh order, om, 100 mm.

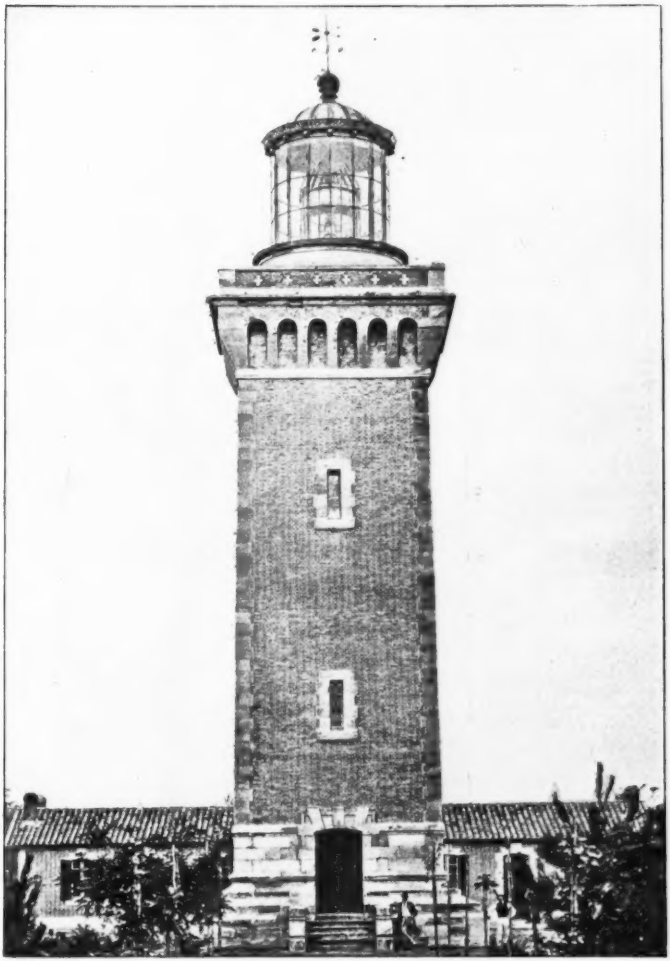


FIG. 3. LIGHTHOUSE OF HOURTIN, GIRONDE.

in the reservoir. A ladder fixed to the platform permits entrance through a trap to the lantern, so that the burner may readily be reached. The rotating mechanism consists of a clockwork movement, driven by a weight acting upon a shaft. This shaft is carried by two

FIG. 4. OPTICAL APPARATUS OF THE LIGHTHOUSE OF HOURTIN.

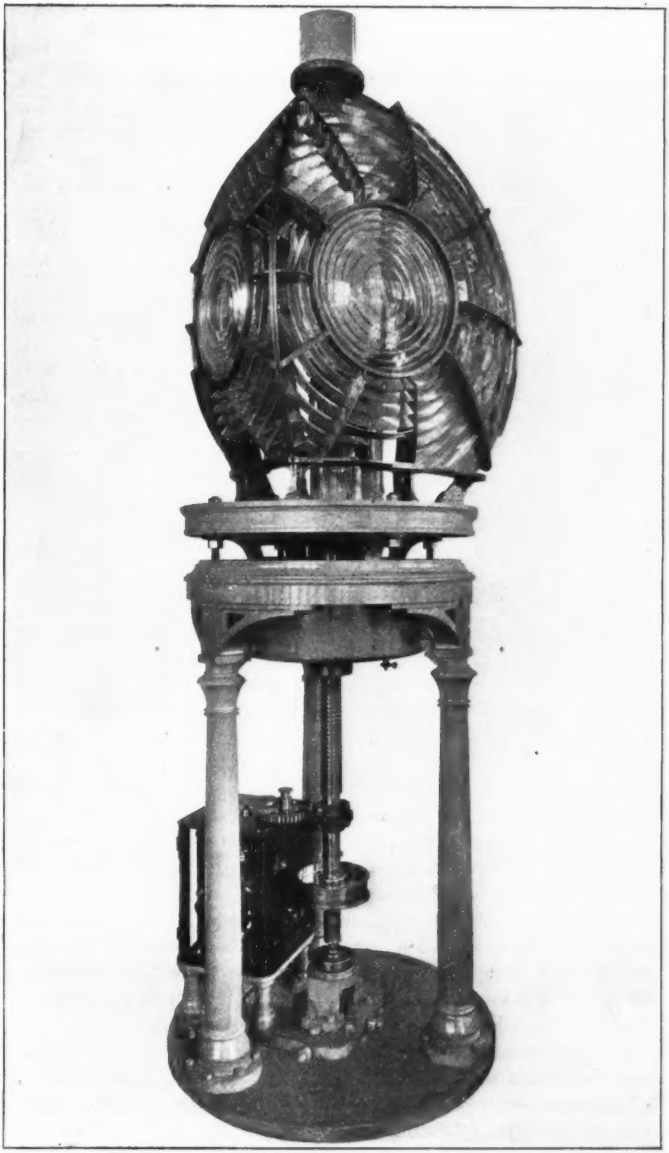


FIG. 5. APPARATUS FOR TWO-GROUP LIGHTNING FLASH, BUILT FOR THE PORQUEROLLES LIGHTHOUSE.

bearings that rest upon a pier on the floor, and is prolonged to the room below, where it rests in a socket. The arrangement is similar to that used in all lightning-flash systems. Attached rigidly to the shaft is an annular float, immersed in a vessel like it in form and containing mercury. The buoyant action of the liquid supports the weight of the apparatus, and greatly reduces the friction. In this way the resistance is much diminished, and a comparatively small driving weight is sufficient to move the clockwork by which the rotation is effected. With this mechanism it is possible to attain rotative speeds which were out of the question with the old form of revolving lantern carried upon balls or conical rollers.

The apparatus at the Hourtin lighthouse was constructed by MM. Barbier and Bénard, of Paris. The total cost, including the lens system, fittings, mercury, etc., was 57,360 francs. Its luminous power is 19,000 carcel-burners, and it emits regularly, every five seconds, flashes $\frac{1}{10}$ of a second in duration.

The lightning-flash system is also well adapted for use for groups of two, three, or four flashes. An example of this arrangement is found in an apparatus of the third order with two group flashes, recently erected at Porquerolles, one of the Hyères islands in the Mediterranean. The optical arrangement of this light is shown in Fig. 5. Assuming it to be divided by a vertical plane through the focus, each half is composed of two symmetrical and identical lens systems. A catoptric spherical reflector of silvered glass, together with the oil reservoir, occupies an angle of 90°, and returns to the lenses the light which it receives from the flame. This "dead" angle permits access to the interior, and simplifies the general arrangement. This apparatus, made by MM. Barbier and Bénard, cost 25,950 francs, and has a luminous power of 7,000 carcels.

The hyperradiant lighthouse of Cape d'Antifer, which formed a notable feature of the Paris Exposition of 1889, deserves especial mention. The lighthouse, which was inaugurated on July 15, 1894, contains a peculiar form of lantern, also constructed by MM. Barbier and Bénard. The optical system (Fig. 6), which is no less than 4 metres in height, is of 1.33 metres' focal length, and consists of six panels. Each lens system consists of twenty-six upper catadioptric elements, ten intermediate dioptric elements, and twelve lower catadioptric elements. The luminous power is equal to 22,000 carcels. The light appears in flashes one second in duration, followed by eclipses of about nineteen seconds. It is hardly worth while to go into further details of this light, for, although the first of its kind in France, it will also be the last. Its cost was very great (49,000 francs), and the lightning flash system offers a great superiority with a much

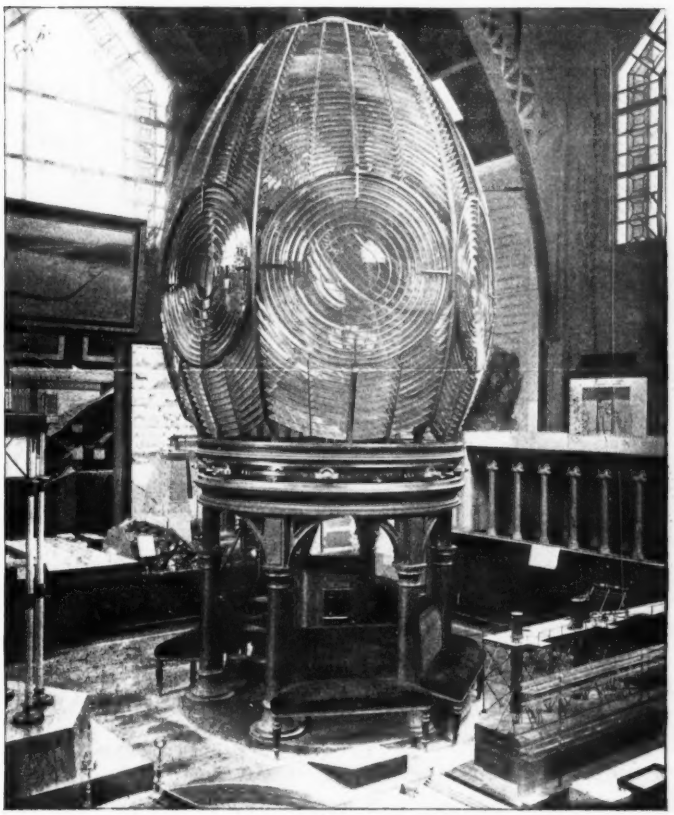


FIG. 6. HYPERRADIANT LIGHTING APPARATUS FOR THE LIGHTHOUSE OF CAPE D'ANTIFER.

smaller apparatus and less cost. Nevertheless this unique specimen is worthy of notice.

We now come to the consideration of electric lightning-flash lights.

A law, dated April 3, 1882, had sanctioned a programme offered by M. Allard, chief engineer of the French lighthouse department, which provided for the construction of forty-six electric lighthouses, to be distributed along the coast in such a manner as to form an uninterrupted belt of lights, under the ordinary conditions of atmospheric transparency. The work was begun by the construction of

the light at Baleines (Fig. 7), at the Isle de Ré, and that at Calais (1883), and was continued by the construction of those at La Cauche (1884) and Dunkerque (1885). In 1886 an examination was made into the actual needs of navigation, whereby it was found that the principal object of lighting was rather to facilitate landings at certain predetermined ports than to aid in coasting from cape to cape, along

FIG. 7. LIGHTHOUSE OF BALEINES, ILE DE RÉ.

FIG. 8. LIGHTHOUSE ON THE POINT OF BARFLEUR, MANCHE.

the shore. It was then seen that the powerful electric lights should preferably be reserved for the lighthouses at the great ports, and that oil-lamps furnished indications sufficiently distinct for the other points. These considerations led to the decision to construct a smaller number of electric lighthouses, thirteen at most, and to proceed successively with those at Creach, on the island of Ouessant (1888), at Belle-Isle (1890), and at Barfleur (1892),—Fig. 8. These lights emit flashes of but a single color and very rapidly; for red and white lights are absorbed by the atmosphere in unequal

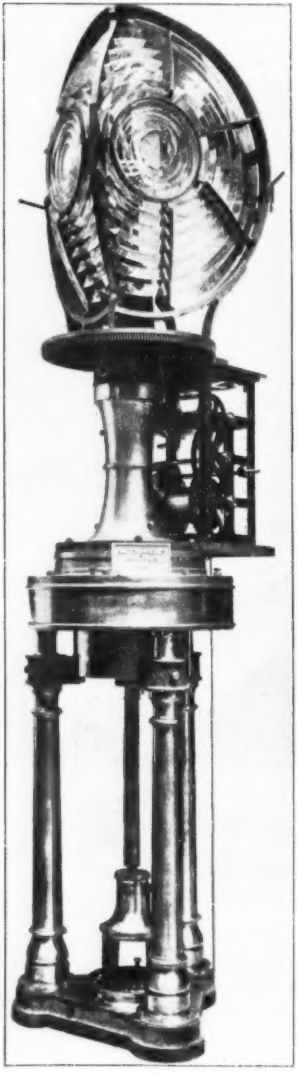


FIG. 9. OPTICAL APPARATUS, LA COUBRE.

proportions, and that it is impossible to insure an equal range for white and colored flashes,—a fact which renders any flash system involving a combination of colors especially unfit for harbor lighting and liable to result in serious consequences.

We will now proceed to the details of the system of illumination used in these three lighthouses, as well as in the electric lighthouses erected at la Hève in 1893, and at la Coubre and the island of Yeu in 1895. Fig. 9 represents the optical apparatus of the lighthouse at the Point de la Coubre, at the mouth of the Gironde. Both arrangements consist of a double system of lenses, giving groups of two flashes every ten seconds. Their luminous intensity varies from 2,250,000 carcels to 1,900,000, or 1,100,000, according to the state of the atmosphere. Without going into the details of the successive improvements which have been introduced, it suffices to state that, by suppressing the useless rays, reducing the number of lenses, and substituting bi-focal lenses for lenses of single focus, the apparatus has been rendered six times more powerful than before, the motive power and expense of operation remaining unchanged.

The complete description of the new and splendid Eckmühl lighthouse, which typifies all that is best and newest in work of this character, is reserved for the second and concluding portion of this paper.

LEGAL ASPECTS OF ELECTRIC STREET TRACTION IN ENGLAND.

By E. F. Vesey Knox.

THE people of England have cheap food, due, firstly, to free trade, and, secondly, to the enormous improvements in marine transportation introduced within the last twenty years. The consequent increase in commerce and manufacture has, within a brief period, more than doubled the English urban population. But the very increase of population has brought with it an increase in the burden of house-rent which threatens to neutralise the advantage that cheap food has given to England in the industrial competition of the world. A workman in the eighteenth century worked in his own workshop or his own house. Very often, as in the case of the hand-loom weavers in the north of Ireland, his house was in the country, and he brought his products to market in much the same way as the small farmer did. When the factory system was introduced, it became necessary for him to live near the factory. At first this presented little difficulty. But the development of industrial organization has required the concentration of factories where special facilities for transport are available. If the workman to-day wishes to live near his work, he has to pay dearly for the advantage of easy access. He has to compete for his few square yards of ground with tens of thousands of other workmen, with manufacturers, who covet the ground for factories and warehouses, and with shopkeepers, whose trade tends to become centralized in the same way as that of the manufacturer. Under these circumstances the workman has to pay a heavy price for his little home, and no form of legislation about ground rent can permanently reduce the price. The legislature may so tax ground rents as to divert the "unearned increment" into other pockets, or the municipality may use the money or the credit of the ratepayers to provide artisans' dwellings in central places at less than cost; but in some form the price must be paid, and, in the ultimate result, the increased cost of housing the workingmen means an increase in the cost of production. The London labourer receives more money than the labourer in the country, but he is no richer; the greater wage is expended in paying the higher rent. The wage cannot be reduced, any more than the rent can be reduced, by the wisdom of parliament. And thus it is that the concentration of industry which sixty years of cheap food have brought about in the little island of Great Britain threatens to become a disadvantage.

Various modes of mitigating this evil have been attempted. The first and most simple is to move the factory to a suburb or a country place. Where the industry is entirely self-supporting, this may be practicable and profitable. Industrial changes are practicable only when profitable. But this is very seldom the case. The only industries in which there has been any marked tendency to move outwards are those in which the cost of labour bears an unusually large proportion to the cost of the finished product,—such as printing,—and the progress of invention makes the number of such industries steadily decline. Every improvement in labour-saving machinery diminishes the proportion which the labour-bill bears to the cost of the product. Some people think that the distribution of electrical power on a large scale will enable industries to be carried on to advantage in smaller places within the radius of supply, but it seems at least as likely that the application of electrical power to manufactures will rather tend to concentrate factories by diminishing the dirt and noise which such a concentration involves where each factory has its own steam-equipment. Thus not much is to be hoped for from the distribution of factories; the tendency of the age is in the opposite direction.

The second expedient has been the erection of "model dwellings," by which a larger population is enabled to be housed on a small bit of land in the centre of the city. The extra cost of the land is thus divided among a larger number. But the old law of diminishing returns, which the Ricardian economists invented to express the fact that land cannot be made to yield an indefinite increase of crops, is equally true when applied to land as a place of human habitation. No amount of skill in the sanitary arts can make it possible to profitably and healthily house more than a certain number of human beings on an acre of land. Model dwellings have not done more than mitigate the appallingly large death-rate in central London, where it is sometimes five times as heavy as in the healthier, because less concentrated, suburbs.

Besides the greater cost of labour, and consequently of production, the concentration of urban population has many evil effects. There is the stunting of physical and mental growth in the children, rendering the labourers of the future less efficient. There is a vast amount of personal discomfort for the men and women, driving some of them to the public house and others into a condition of discontent which makes them less efficient labourers as well as dangerous members of the body politic. In the building trades (which in London are the largest single group of trades) labourers try to follow their work from one district to another. What a pity it is, from every point of view, that they cannot follow their work without changing their place of abode!

The middle and upper classes in the towns have long ceased to try to live near their work. They start work later in the day, after their breakfast, and find the journey to and fro less inconvenient than workingmen do. Some of them can afford to drive; others are season-ticket holders on the railways. Above all, they follow one route year after year, and have not to change their route with the changes in the place of work. But even they, especially in London, lose much of their efficiency as brain-workers from the inconvenience of access, or else pay immense sums as rent in the more accessible districts.

Obviously, then, the key to the problem of healthy living for all classes must be found in better means of moving to and fro within our cities, so that workers may obtain access to their work, though living at a distance from it. Better urban transit is the greatest of social needs. Necessity is the mother of invention, and invention has been busier in improving the means of urban transit during the past ten years than it ever was before. But the stupidity of parliament and county councils has prevented England, where the need was greatest, from sharing in the advantages which science placed within reach of our people. The railways cannot do more than part of the work. Some of them, especially the Great Eastern, have made great efforts, at enormous cost, to help in spreading population. But in many directions land is so expensive that further suburban lines are almost impossible, while the difficulty of providing sufficient station-accommodation in the centre is also increasing. The statistical officer of the London county council, with every temptation to make out a case against the companies, admits that, if every company gave up all the early morning hours to a five-minute service of workmen's trains, only a very small proportion of the London workmen would be taken to their place of work, while he does not attempt to tackle the much more difficult problem of how to get them home again in the afternoon. Underground electric railways may help towards the solution of the problem, but their construction is so expensive that they can never afford to give what, in the case of electric street transit, would be considered cheap fares; hence they must be put down as conveniences mainly for the middle class.

Furthermore, no sort of railway with big trains, stopping only at stations, can give the constant service which electric tramways can, not merely on main lines, but on cross routes, taking one from door to door. I am dealing with the social side of electric traction. From that point of view I venture to contend that the best system of transit is that which will take the humblest citizen from his own street-corner to his work, with dry feet, in good air, and at a cheap rate. The Londoner may very probably object that this is just what

tramways do not do; they run only on main thoroughfares, and are really less useful to the dwellers in by-streets than the omnibus. But this is because tramways in London have never had a fair chance. The difficulty of promoting them, the insecurity of tenure, the municipal jealousy of private enterprise, and the unwillingness of the municipality itself to undertake new enterprises, have combined to keep London behind all the other cities of the world. The following is a list of the existing tramways within the metropolitan police district, with its six millions of people, giving in each case the length of single and double line.

Names of tramway and gauge.	Double line.	Single line.	Total length.
	m. ch.	m. ch.	m. ch.
Croydon	1.30	5.33	6.63
Croydon Corporation	5	9	14
Gravesend, Rosherville & Northfleet.	17	2. 3	2.20
Harrow Road and Paddington	1.57	1.10	2.67
Highgate hill	48	9	57
London	22.54	1.27	24. 1
London, Camberwell Dulwich	24	2.47	2.71
London County Council	4.18	10	4.28
London, Deptford and Greenwich	1. 9	3.63	4.72
London Southern	1.73	3.67	5.60
London Street	7.77	1.12	9. 9
London United	5.68	3.15	9. 3
North Metropolitan	38.78	12.57	51.55
South Eastern Metropolitan	61	1.64	2.45
South London	8.44	4.26	12.70
Total	96.21	43.52	139.73

There have been slight changes in ownership since the date of the parliamentary return from which these figures are taken, but the lengths are correct. What do these figures prove?

1. That the total length of tramway is only about one mile for every 43,000 people, as against one mile for every 10,000, which may be roughly taken as the average of progressive European cities, and one mile for every 3,000 which is rather a low average for America. London, according to the American standard, should have at least 1,500 miles of trolley line.

2. That nearly one-third of the total length of line is single line, thus creating the maximum of obstruction to other traffic and giving the minimum of public service.

3. That about half the total length of line is split up into thirteen separate undertakings, with an average length of about five miles each, thus minimizing the possibilities of through service by cross-

routes. Furthermore, with the exception of two short bits of cable, London trams are all drawn by horses.

To sum up the situation, London has a greater social need for good street transit than any other city. London presents the greatest field in the world for the profitable investment of money, whether private or municipal, in street-transit facilities. London is the richest city in the world, and its municipality can borrow at the lowest rate. Yet London has the most meagre system of street transit in the world, and this system is operated by the most antiquated method.

To explain this extraordinary state of things it is necessary to give a short statement of the English law concerning tramway undertakings, which is perhaps the most striking example in recent history of the power of a legislature to retard human progress.

Under the common law of England the highway dedicated to the use of the inhabitants at large cannot be broken up for any purpose without parliamentary authority. It is the king's highway, and to break it up is an offence against the king, punishable on indictment. In early times the king, of his prerogative, used to issue letters patent for the diversion, or widening, or closing, of highways, and in most European countries tramway concessions are granted by the executive. But in modern times the executive in England has no such power. In most American States the authority to break up the streets can be given by the municipality, and no legislation is required. In England, though the street is "vested" by law in the municipality, the municipality is rather a caretaker than an owner, and the permission of both executive and municipality is of no avail without the sanction of the legislature. George Francis Train got the consent of the municipality, and laid down a tramway, but he was indicted and convicted, like any pickpocket. With all the extensions of municipal authority within the present century, parliament has never yet given a municipality power to authorize, at its discretion, the breaking-up of the public streets. It will authorize private undertakers to break them up, or will authorize the municipality as undertakers to break them up, but it has never allowed a municipality to authorize others to break them up. In fact, parliament will not trust the municipalities, or even the county councils, to make their own bargains with those who desire to supply gas, or water, or electricity, or traction facilities, within the muncipal boundary. In most cases, on the other hand, parliament requires both the municipality and the executive to be satisfied in the first instance before granting traction facilities. Thus on the continent the promoter has to satisfy the executive only or the executive and the municipality; in America he has usually to satisfy the municipality only; in England he must run the gauntlet of all three.

There are several formal modes of proceeding by which a tramway may be authorized:

I. In Ireland, under an act passed in 1860, the privy council, to whom the authority of parliament has for this purpose been delegated, has power to authorize either urban tramways or rural light railways, and no purchase clause need be inserted. It must be largely due to this exceptional procedure that Ireland is so much beyond England in tramway facilities, in spite of the greater financial difficulties encountered there. Not merely has the act been useful in its direct effect, but it has been useful indirectly by accustoming municipalities to the beneficial results of security of tenure in encouraging enterprise. Thus it comes that even the tramways authorized by act of parliament have not been so strictly tied down in Ireland as in England. In Dublin and its suburbs, with a population little more than one-twentieth that of London and its suburbs, there are already in operation seventy miles of tramway. Much of this is already equipped for electrical or steam traction, and in the course of this year there will be no horse-trams left in Dublin, while extensions which are projected will bring the total tramway mileage to about one hundred miles. The corporation of the city of Dublin have extended the purchase term for forty-two years, at a rent, or way leave, of £10,000 a year, while some of the suburban lines are held in perpetuity.

II. In Great Britain the principal method of proceeding has been under the tramways act of 1870, which happily does not extend to Ireland. Mr. Shaw Lefevre told me the other day that he was proud of having carried that act through the House of Commons, but I venture to contend that no other act was ever passed which has done so much harm to the true interests of the people. It professed to be an act to facilitate the construction of tramways, and I believe this to have been its real intention. It allowed tramways to be constructed under provisional order of the board of trade confirmed by act of parliament, and, in cases where there was no opposition, it undoubtedly diminished promotion expenses. Where there is opposition, there is really no saving, for the opponents can fight the bill to confirm the provisional order before committee in both houses of parliament. Furthermore, the procedure is hampered by a number of limitations. It provides, in the first place, that for at least two-thirds the length of the tramway both the local and road authority must consent. In London the local authority is the county council, while the road authority is the vestry, or district board of works. The county council has persistently refused, without regard to the circumstances of the locality, to consent to any order for the construction of new tramways, or the electrical equipment of existing tramways, on the

doctrinaire ground that such undertakings should never be allowed under private management, while they have not themselves constructed a single mile of line, and are at this moment discussing whether the time is ripe to equip for electrical working the lines which they are buying from the companies.

The vestries, on the other hand, have been guided by the most narrow parochial reasons. They have forced tramways to come to an end at ridiculously inconvenient places, and in some cases have positively refused to allow any tramways at all, lest they should have workingmen on tramcars passing through select streets on their way to and from homes in remote suburbs. Yet there is no power under the tramways act to overrule such selfishness in the interest of the greatest number, and the London county council now finds itself blocked by it just as private promoters have been.

In the second place, there is no power under the tramways act to take land compulsorily for street-widening or for the making of new streets or roads along which the tramway is to run. Except for the limited powers in London under Michael Angelo Taylor's act, local authorities likewise have no power to take land for such purposes without special parliamentary authorization, and it was not to be expected that parliament would give greater facilities to a tramway promoter than to a local authority. I venture to contend that the power should be given to both. Barring roads made under special turnpike acts, English roads have been laid out by individual landowners solely for the benefit of their own estates. I believe that in many cases the landowners have purposely made the roads narrow and inconvenient as thoroughfares, to prevent the country beyond from being readily developed for building. Apart from set purpose, numbers of country lanes or village streets have become, as it were by accident, main thoroughfares. To fit them for tramways, widenings are necessary, while in remoter districts it would often be cheaper to make new, straight roads through the fields with a central electric railway. Under the tramways act all this is impossible.

In the third place, the tramways act provided that the tramway should be in the middle of the road, whereas along a blank wall the side of the road is often the most convenient place; and it was not to be authorized if for 30 feet the distance between the outer rail and the curb was less than 9½ feet and one-third of the owners or occupiers abutting objected. This provision has had the most disastrous results. Many lines of great public utility have been blocked entirely by frontagers. Others have been made as single lines, where they ought to have been double.

In the fourth place, the promoters were placed under the obliga-

tion of repairing the road between the rails and for eighteen inches on each side. This has proved a most unfortunate provision. Constant bickerings have arisen with local authorities. The local authority may change the paving of the rest of the street from stone to wood, but has no power to insist that the tramway company shall follow its example. The tramway company, having regard to the purchase clause, has often refused to make any change. It may or may not be just to compel a tramway company to contribute more than an omnibus company to the upkeep of the roads, though, where the motive power is electricity, it touches no part of the road except the rails. But, whatever contribution is fairly required should be in money, and not in work, so as to avoid, as far as possible, the disadvantage of a dual authority over the roads.

But the most serious defect of the act is the purchase clause. Under clause 43 the local authority has power to buy the undertaking at the end of twenty-one years, "upon terms of paying the then value (exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatever) of the tramway." As this clause has now been interpreted, it means that the company will get the proper cost of promotion and construction,* less an allowance for depreciation. The price is not, in strict language, "old-iron value," but it is something much less than the actual value of the undertaking, if that undertaking has been successful. The forty-third section has enabled the local authorities to acquire some flourishing enterprises at a very low price, but it has had other incidental effects, upon which its framers scarcely calculated. From the first it discouraged the best class of capitalist—the capitalist, that is to say, who is content with the lowest return—from investing in tramway undertakings. Small investors were attracted by the higher rate of interest, but, when they found

* Though cases as to the interpretation of what Lord Herschell called the "not very felicitous" language of the act went twice to the House of Lords, one point seems to me to have been left in some doubt,—*viz.*, whether the arbitrator is to take into account the actual cost of promotion and construction, or what the cost would be at the time of purchase. Apparently the Edinburgh arbitrator took the actual cost of promotion as the test of the promotion allowance, but both he and Sir Frederick Bramwell refrained from explaining how they arrived at the proper cost of construction, and the judges did not enter into that question. It may, in my opinion, be very strongly contended that, though the cost of construction has perhaps remained, on the whole, about the same, the cost of promotion has very much increased. Thus, when the county council tries now to get the road authorities to assent to new tramways, they ask that the council should assume the whole cost, not merely of repairing, but even of lighting the road, and, if any of the principal existing tramways were to be promoted afresh, the vestries would doubtless insist on some such payments. The county council, in acquiring the existing undertaking, acquires it free from obligations so onerous, and, when estimating the cost of promotion as part of the "then value of the tramway," the arbitrator should make a capital allowance for the saving which the county council makes through the forethought of the promoters in obtaining powers before the greed of the road authorities got to its present pitch. I hope that this point will be argued in some future case.

out what the purchase clause meant, they refused to invest any more money in new tramways. The directors and managers, having nothing to gain by building up a good permanent business, ran the concerns with a view merely to immediate profits. During the last seven or eight years of the twenty-one they made scarcely any improvements, and it has so happened that during the last decade all the rest of the world has been adopting electricity. Thus the tramways act of 1870 is the principal reason why English workingmen enjoy so few facilities for cheap street transit. For many years past scarcely any lines have been promoted under it, except by municipal corporations, whose undertakings cannot be compulsorily purchased.

III. Even corporations, however, find the restrictions of the tramways act tedious, and many of them, caring little for the possibility of greater expense, have recently proceeded by separate private bill. It may be asked why the promoter should not ignore the tramways act and go for a tramway bill as he would for a railway bill. The answer is threefold. In the first place, parliament, having provided the procedure by provisional order, discourages applications in any other way, unless it can be clearly shown that the scheme involves things which can not be done under the tramways act,—*e. g.*, the compulsory acquisition of land. Secondly, the standing orders of parliament make the consent of the road authority an absolute condition precedent, and this standing order is seldom, if ever, suspended. The local authorities in many cases are so enamoured of the prospect of buying up the tramway cheap at the end of twenty-one years that they will not consent to the bill unless the purchase clause of the act of 1870 is inserted. They may, in the course of years, realize how short-sighted this policy is, but in the meantime they are content with the stereotyped answer: "We must not alienate our roads"—as if roads were made to be looked at and not to be used by the greatest number at the quickest pace and the cheapest price which scientific improvements permit. In the third place, a private bill is necessarily expensive, and most tramway schemes will not bear to be overloaded with promotion money.

IV. Parliament has now provided, under the light railways act of 1896, a new procedure, which has great possibilities. The light railway commissioners have, in theory at least, great powers. After holding a local inquiry, they may, with the consent of the board of trade, authorize a light railway anywhere, wholly on the roads, or partly on the roads and partly on private land and partly on roadside waste. They may allow land to be taken compulsorily to widen a road along which the railway is to be run, or for the railway itself, though they may not allow sufficient land to be taken to make a new

road. The railway may be worked by any motive power, and may be, to all intents and purposes, an urban tramway. The consent of the local authority or of frontagers is not required.

As yet, however, the light railway commissioners have shown a perhaps not unnatural hesitation in exercising their powers. They have, it is true, overruled generally the very absurd objection that the act was not to apply to towns. The House of Commons had fair warning that road railways were contemplated. Thus Mr. Ritchie, in introducing the bill, referred to the Belgian light railways as "a great system of steam tramways. The main roads were used for the lines, although occasionally a strip of land by the side of the road was taken, or a short cut across country was made." He then went on to show that the Belgian system was better than the French (Hansard, 4th series, vol. 37, p. 738). In the House of Lords Lord Welby, acting on behalf of the London county council, moved to insert a provision making it necessary for the order, when objected to by a county council, to be confirmed by parliament. "The noble lord said that the house would observe that in the bill there was no definition of 'light railway,' and he understood that the provisions of the bill applied, and were intended to apply, to tramways in towns. . . . His attention was drawn to the clause as a member of the London county council, but he made no distinction between London and other towns in this respect." The amendment was opposed by Lord Salisbury, and rejected by 79 to 31. It is idle, therefore, to deny that the act was intended to apply to road lines, and even to road lines in London, and the commissioners have, on this general question, clearly expressed their view.

But in practice they do not feel able to override the local authority, except in very strong cases. On the other hand, the commissioners do not feel bound to grant powers simply because the local authority consents. Thus at Hastings they refused powers, because a minority in the corporation, none of whom lived on the line of route, objected strongly. The minority produced evidence to show that distinguished physicians, including Sir Samuel Wilkes, the president of the College of Physicians, regarded electric tramways as injurious to the health of invalids, and the commissioners did not feel justified in granting powers where a considerable minority of the population were so strongly prejudiced against the proposal. Thus the light railway act has not yet been quite so fruitful of new powers as promoters had hoped. Doubtless Lord Jersey, who, with conspicuous self-sacrifice, gives nearly his whole time to the work without fee or reward, is anxious not to move in advance of public opinion, and it cannot be denied that a very large number, in the upper middle classes especially, are opposed to

tramways of all kinds. I do not believe that this feeling will be quickly eradicated. The dweller in Hampstead enjoys exceptional advantages, because he is within the four-mile circle from Charing Cross, but within a mile or less of open country. He pays at the rate of £5,000 an acre for freehold land, partly because of this exceptional advantage. A mile further out equally good land can be got for £500, two miles further for £150, an acre; but the building will not go in advance of the means of communication. To the Hampstead owner or occupier it is a matter of supreme importance that the land beyond should not become available for the homes of the workers in the West End of London. So he hates, and always will hate, tramways. The worst of it is that, if the light railway commissioners were to overrule this sort of villa-owner's selfishness, they might find themselves without any backing from those who are supposed to represent the workers, but who mutter "monopoly!" when any private investor attempts to do anything, and fancy that in that one term of abuse they have summed up all political wisdom.

I do not doubt that eventually the light railways act will prove to be the best means of promoting electric-traction schemes. The worst of it is that every year is precious, and that every year enormous improvements are being made in every country but England. I venture to suggest that, to facilitate the adoption of electric traction under the light railways act, certain amendments of the act are desirable. They are not very revolutionary, but I believe they would be useful.

1. I believe it would be well to give the commissioners express power to incorporate any of the provisions of the tramways act, with or without modification. They incorporate many provisions already, but an express reference to the act might soothe local authorities.

2. If electric-lighting powers could be granted by the same order, some expense would be saved, while many of the richer people who oppose traction schemes might be attracted by the prospect of electric light in places where it would not be commercially possible apart from traction.

3. It is very desirable that the commissioners should be able to authorize the taking of fore-courts or a slice of garden for road-widening, without purchase of the whole property, under section 92 of the lands clauses act.

4. I see no reason why, when land is taken for a railway, enough should not be taken to make a road, along which the railway or tramway would run. This would be to the interest of the land-owner whose land would be opened up for building, but some land-owners oppose every change. Sometimes the railway might run between trees in the centre of the road, except for occasional crossing-places.

Thus we might have a foot-path, a road twenty-five feet wide, a row of poplars, a double line of tramway, another row of poplars, and another twenty-five-foot road. The tramway track need not be paved, except at crossing-places, and thus something would be saved in construction and maintenance,—perhaps nearly enough to buy the extra land,—while the freedom from obstruction would allow rapid running. No one can doubt that a main road laid out in that way would soon be built upon, while the objection of the carriage folk would be reduced to a minimum. If the promoter has security of tenure (which he gets under the light railways act), he can bear the increased expense, and the advantage of the security is thus reaped by the public.

5. The board of trade is authorized by the act only to appoint a single paid commissioner, and his salary is not to exceed £1,000 a year. If the work grows, as seems probable, further paid assistance will clearly be required.

Curiously enough, no municipality has yet proceeded to obtain powers to construct a line under the light railways act. The reason for this is very simple. The old objection to socialism—that it means new and crude experiments at the public expense—is almost entirely groundless. The real danger is in the opposite direction. The town councillor or county councillor does not like to risk the ratepayers' money in experiments which will not fructify until long after the next municipal election. It is because tramways have been made the subject of an experiment in municipal socialism that England is ten years behind the rest of the world in electric traction. It is true that the municipalities are now, in some cases, adopting electric traction on the lines they have bought so cheaply. Probably in a year or two they will be boasting of their success. But no mere money-saving in the cost of acquiring the existing lines will compensate for ten years of delay, ten years of slum life for children who, but for the tramways act, might have been brought up among healthy surroundings, ten years of comparative stagnation in the electrical-engineering trade, while the greatest of the new industries of the century has become almost the monopoly of the great republic which has been liberal enough to give free play to private enterprise and democratic enough to see that the people got facilities for cheap transit on free streets.

I understand that in America some learned professors have been pointing to the English examples as evidence of what benefit can be derived from the chary grant of franchises. But the municipalities which granted franchises readily had a much wider understanding of the needs of the public than the professors.

EFFECTIVE SYSTEMS OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

THE NATIONAL SWITCH AND SIGNAL COMPANY'S METHODS.

THE cost-keeping system of the company whose methods form the topic of this paper was devised by Mr. Chas. Hansel, vice president and general manager, who has kindly, if reluctantly, consented to this necessarily brief description. The system is adapted to any number of factory departments and workmen, and is designed throughout with a view to the accuracy of detail and exact knowledge of flat, factory, and installation costs which is forced by the close competition in this branch of manufacture.

These costs are gathered primarily by cards and recorded finally in books, the books being introduced for differential expositions of the costs, so that comparisons of successive results are forced upon the attention of the manager. The inventory is made monthly, and the system unquestionably presents the possibility of a very close approximation to accurate cost-keeping. A system of specifying all accounts by numbers, called "Key to Distribution of Voucher," avoids all possibility of conveying information of actual performances and results to any one not in possession of this key. The first ten numbers are devoted to voucher titles, under the general head of "Advertising," sub-divided into (1) "catalogues and pamphlets, ledger page 1"; (2) "journal cards, page 2"; (3) "exhibits, ledger page 3"; (4) "photographs, page 4"; (5) "entertainment, page 5." The remaining four numbers of the subdivision, 6, 7, 8, and 9, are as yet unfilled. The next seven numbers of the main division are devoted to realty and buildings accounts, under the general title of "Buildings and Lands," the separate item accounts being posted on ledger pages 9 to 13 inclusive. Nos. 18 to 24 cover the divided accounts, grouped together under the general title of "Draughting"; Nos. 25 to 34, inclusive, are under the general title of "Experimental"; Nos. 35 to 50, inclusive, cover the various divisions of the "Factory Pay-roll," divided as follows: "blacksmith productive, blacksmith non-productive, electrical productive, electrical non-productive, foundry productive, machine shop productive, machine shop non-productive, wood shop productive, wood shop non-productive, shipping department productive, shipping department non-productive." This list of pay-roll distributions will give the expert accountant a fair idea of the minute subdivisions of the prime

cost and expense accounts. In all there are 149 sub-accounts, under 24 general voucher titles, in actual existence on the ledger under number symbols.

As the factory operations of the National Switch and Signal Company include at least seven well-defined departments,—designing, wood-working, machine construction, drop forging, blacksmithing, founding, and installation,—it follows that a sufficient system of factory-accounting for this establishment is very likely to cover the needs of a great majority of manufactories in general. While these 149 sub-accounts may seem at first sight burdensome, especially in case of a small factory, they are, on the contrary, labor saving.

To illustrate, suppose a boy were required to sort a pile of machine-shop scrap containing 149 different things; then, if the boy was provided at the outset with 149 boxes, each having a sample article attached, he would sort the pile correctly and without difficulty. If he had a smaller number of boxes, he would often be in uncertainty as to the correct place for a piece he had in his hand. Precisely the same is true of accounting. When Mr. Hansel completed this cost-keeping system, he believed it would produce accurate results, but he feared it would prove too heavy for the works. The system was installed, and gave correct results, and the cost for the first year was $135 *less* than the cost of cost-keeping the previous year with a make-shift system, which was tolerated only because it was simple, inasmuch as it had few accounts, and was supposed to be inexpensive, because things were lumped and guessed at, at the expense of accuracy.

In the Hansel system, three costs are kept,—the flat cost (including labor and material only), the factory cost (factory expense added to flat cost), and total cost (including all expenses of every kind).

The factory expense account was originally charged to no less than 84 separate job numbers, beginning with Job No. 1, engine driver's time, and ending with Job No. 84, machine-shop-helper's time not directly chargeable to any shop order. These 84 standing job numbers include labor and material for different shop repairs, sweeping, handling stores, cupola tending, and coremaking, and are intended to include and separate all items of expense not directly chargeable to any productive order number.

This schedule of expense divisions is as follows, covering labor and materials for which no regular production order is issued. Division No. 1, engine driver's time; 2, engine room supplies; 3, watchman's time; 4, sweeping and cleaning machine shop; 5, same, electrical department; 6, same, foundry; 7, same, wood shop; 8, same, blacksmith shop; 9, 10, 11, 12, and 13, oiling shafting, machine shop, electrical shop, foundry, wood shop, and blacksmith

shop; 14, 15, 16, unloading coal for blacksmith shop, boilers, and pig-iron, coke, sand, and coal for foundry; 17, setting up new machines in factory; 18, starting new machines in work; 19, materials for machine-shop tools; 20, labor on same; 21, 22, same, electrical shop; 23, 24, same, foundry; 25, 26, same, wood shop; 27, 28, same, blacksmith shop; 29, materials for building repairs, drains, fences, tracks, and sidewalks; 30, same, labor; 31, 32, material for machine repairs and renewals, and labor on same; 33, 34, same, electric department; 35, 36, same, foundry; 37, 38, same, wood shop; 39, 40, same, blacksmith shop; 41, 42, material and labor for pattern repairs; 43, 44, same, flasks; 45, 46, same, "floating equipment" (meaning the tools used in erecting outside of the factory: a fixed charge of $20.00 is made for loss, breakage, and depreciation on each "floating plant" each time it is issued); 47, 48, material and labor to put in order stores returned from contract installations; 49, 50, material and labor for boxing other than contracts; 51, 52, material and labor repairs of office furniture; 53, 54, material and labor to repair jigs and templets, machine-shop; 55, 56, same, electric department; 57, 58, same, wood shop; 59, 60, same, blacksmith shop (new formers, jigs, and templates are made only on production orders issued by the superintendent); 61, unloading and handling stores; 62, handling "Bushnell work" (delivery to them); 63, 64, materials and labor repairs to building No. 1; 65, 66, same, building No. 2; 67, 68, same, building No. 3; 69, 70, same, building No. 4; 71, 72, material and labor to repair fixtures in machine-shop (meaning furniture, fittings, heating appliances, benches, and shelving"); 73, 74, same, electric department; 75, 76, same, foundry; 77, 78, same, wood shop; 79, 80, same, blacksmith shop; 81, core maker, foundry; 82, cupola tender; 83, foundry labor in grinding and cleaning castings, etc.; 84, helper in machine shop.

The printed forms used are given below. To save space the text and size of each form are given, without attempting, as in previous papers, to show the actual style of the text on the printed form.

Form No. 1. Requisition to purchase. This is approved at manager's office, issued to purchasing agent, and returned to accounting department for filing and check against invoice. Two sizes; small, 8½ inches by 5 inches; large, 8½ inches by 10 inches. Text:

Date ..... Requisition to Purchase. P. A. Order No.....
To Purchasing Agent: Date ordered.....
You are hereby requested to purchase the following described articles to be delivered to..... Ship via.....

Quantity.	Description.	Remarks.

Approved. .. ..Gen. Manager. Approved. ... .Supt.

Form 2 : small, 7 inches by 6 inches ; large, 7 inches by 12 inches.

Superintendent's order on Storekeeper.

Order No.....

Contract No..... Date.....

Quantity.	Catalog No.	Description.	Remarks.
.....	.....	.....	.....

Directions.			Return Memorandum.		
	Date Shipped		Initial	No.	Remarks.
Date wanted.....	.....		Car.	Car.	
Ship to.....	Month	Day	.....	.....	.....
At.....	.....	.....	.....	.....	.....
Ship via.....					
.....			.....		
Superintendent.			Storekeeper.		

It will be observed that each order has two numbers, the "shop production" order number and the "contract" order number, or, in other words, a selling order number and a shop order number.

Form 3 : size, 7 inches by 5 inches.

Stores Memorandum.

Date.....

On hand.	Required.	Description.	Remarks.
.....	.....	.....	.....

This form is used by the stores keeper to give the superintendent advance information of stores requiring replenishment in the near future.

Form 4. Superintendent's requisition on factory. Size : small, 6 inches square ; large, 6 inches wide by 12 inches high.

Superintendent's Requisition on Factory,

Requisition No..... ... Date..... ...

For Sales Order No.....

Quantity.	Catalog No.	Plan No.	When required.		Remarks.
			Month	Day	
.....	.....	.....			.....

To.....

You are hereby instructed to furnish the above stores, and report when same are ready for delivery.

.....
Superintendent.

The above requisition is complete and ready for delivery.

Dated.... .....

.....
Foreman.

This is used either for production order or for sales order. If used for sales order, the number of the superintendent's order on the storekeeper, form No. 2, will be entered on the form after the words "Sales Order No.....".

Form 5. This is a bound book, each line of each page covering the principal records of one "order number,"—that is, one single

production order, or sales order, in the factory. The width of the page is 14 inches. The up-and-down dimension may be as desired. Each page is headed, in bold type: "Prime Cost Record." Then follows this horizontal line of column heads:

"Order No. Catalog No. Description. Quantity. Weight. Dimensions. Material Used. Non-productive Material. Non-Productive Labor. Royalty. Other Disbursements. Total Expenditure. Average Cost Each. Date Finished. Month. Day."

From the "Average Cost Each" column, the stores keeper enters "prime" costs in Orders Account Book, when any Sales order is filled from stores on hand in the stores room. This column also gives instant information as to the cost of the *last* order of a certain article made, and, of course, forces constant comparisons of successive-order costs of the same article.

Workmen use a mechanical time-recorder requiring the vibration of a lever on entering and leaving the shop. In addition to this record, each workman perforates a five-minute time-card for each job on which he is employed, simply piercing the card at the five-minute points most nearly representing his times of beginning and ending work on the job in hand, the appropriate order number being entered on the card by the foreman. A separate card is used for each order worked on. When the workman enters the shop in the morning, he is furnished with one time-card, which he hangs on the upper hook

TIME CARD.

Workman No..... Date.....

	H.	MIN.										
Date Commenced.....	7	5	10	15	20	25	30	35	40	45	50	55
	8	5	10	15	20	25	30	35	40	45	50	55
Order No.....	9	5	10	15	20	25	30	35	40	45	50	55
	10	5	10	15	20	25	30	35	40	45	50	55
Catalogue No	11	5	10	15	20	25	30	35	40	45	50	55
	12	5	10	15	20	25	30	35	40	45	50	55
Number Pieces.....	1	5	10	15	20	25	30	35	40	45	50	55
	2	5	10	15	20	25	30	35	40	45	50	55
Operation No	3	5	10	15	20	25	30	35	40	45	50	55
	4	5	10	15	20	25	30	35	40	45	50	55
Date Finished.....	5	5	10	15	20	25	30	35	40	45	50	55
	6	5	10	15	20	25	30	35	40	45	50	55

Approved,

....
Foreman.

in his individual time-board, after perforating it at his beginning time. When the job is completed, the card is transferred to the lower hook. The time-cards on the lower hook are removed by the time keeper each morning, cards on the upper hook being left undisturbed. The style of the card, which is 4½ inches square, is given on the preceding page.

This time-card was first used with fifteen-minute divisions. After the cards are collected, the individual totals are compared with the clock record, made to agree therewith, and filed after charging the time to proper orders. Time is paid on the clock record only.

Form 7 is a book, having pages 14 inches wide, headed in bold type "Wages Record," below which is one line of column headings:

Name. No. Dept. Trade. Date engaged—Month, day. Date dismissed—Month, day. Rate per hour. Advanced—Date, month, day, rate. Advanced—Date, month, day, rate. Remarks.

This forms the cost clerk's authority for labor value in prime costs.

Form 8. Time sheet. This is a book form, each page being 14⅞ inches wide, and headed in bold type. "Time for Two Weeks Ending.....189.." Below this is a single line of column heads:

Name. No. Depart. Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday. Distribution as shown by workman's time-card: Hours productive. Hours non-productive. Hour rate. Total productive. Total non-productive. Total due. Remarks.

Each workman is given part of a page, or a whole page, so as to show his time on each order on a separate line.

Form 9 is likewise a book, having pages 14 inches wide, each headed in bold type: "Piece Work Time Book. For Two Weeks Ending.....189.."

Below this is one line of column headings as follows:

Name.	No.	Dept.	Catalog. No.	Pattern No.	Quantity.					
Rate per piece.	Total.	Comparison Time and Piece Work.								
		Total Hours.	Rate per Hour.	Difference.						
				By hour.	By piece.					

Remarks.

Time is transferred from form 8 to form 9 to show comparative value at given hour-rate as compared with piece-rate.

Form 10 is the Piece-Rate Book. The pages are 10½ inches wide, headed in bold type. "Work Rate Book," followed by a single line of column headings as follows:

Catalog. No. Description. Size. Pattern No. Weight, Lbs. Rate per piece. Authorized by.....

The rate on each article is fixed by manager or superintendent.

Form 11. Department requisition. Size, 6 inches square, in different tints for different departments. Text as follows:

Department Requisition on Stores. The following stores are required on account of Supt's. order No..... Job No..... Date.....

Then comes this line of column headings: Quantity. Description. Weight. Remarks. At the foot are two lines of text: Received .....Foreman. By order of .....Foreman.

These orders are entered on the "Disbursing Ledger." The orders are manifolded. The original is delivered to prime cost clerk with "prime" cost of all stores issued thereupon, and the order number is debited accordingly.

Form 12 is a department credit memorandum to stores, size 6 inches square, on differently-tinted papers, text as follows:

Department Credit Memorandum to Stores. Credit order No ..... Job No. ..... with following stores delivered..... ... ...

Then follows this line of column headings: "Quantity. Description. Weight. Condition. Remarks. The text at the foot of this form reads as follows: Above stores received.....Store Keeper. To Store Keeper: Please acknowledge rect. of above described stores .....Foreman."

This is for returning stores drawn for an order, but not used.

Forms 13 and 14 are a Stores Ledger, in which are recorded all receipts and disbursements of material and stock, made on whatever order. The stores received represent all stock or material received, whether from without, by purchase, or from within, by production. If purchased, values are fixed by purchasing agent from invoices, with 5 per cent. added as shop charges; if produced, values are "prime" cost, or flat cost with certain factory expense additions. This ledger shows stock and material on hand. Two ledgers are kept, one for finished stores and one for rough stores. The stores room, under this system, becomes a "clearing house" for the entire factory.

Form 15. "Stores Received Record." Two sizes: small, 6 inches square; large, 6 inches wide by 12 inches high. This form is used as a tally sheet by the stores keeper in receiving, and is as follows:

Stores Received Record. Date ..... The following articles have been received in good order and deposited in Bin No.....

Following is this line of column headings: "Car Initial. Car No. Description." At the foot: "Received and reported by."

Form 16, "Stores Rejected," is used to register articles received in bad order, or for any other reason rejected. It is attached to Form 15, and both are returned with invoice to purchasing agent. Color, pink; size, 6 inches square. Text as follows:

"Date ..... Stores Rejected Report.

To Store Keeper: The following articles have been received in BAD order and rejected. Please give instructions for disposition."

Then follows this line of column headings: "Car Initial. Car No. Description." The foot line is: "Rejected by....."

Form 17, "Stores Returned Memorandum." Size, 7¾ inches by 6 inches. The line of column headings reads:

Date Shipped		Date Returned.		Shipped on	Descrip-	Prime Cost	Return Value.	Loss.
Month	Day.	Month —	Day.	Order No.	tion.	and handl'g.		

This form has no foot-line. Such return stores are charged to stores room at return value, and credited to the original sales order. The bill clerk is authorized to render a corrected bill.

Form 18. Head line, "Daily Cupola Record;" size, 5 inches by 8 inches. Column heads: "Materials. Lbs. Price. Total."

The left-hand vertical column is filled as follows: "Watts, Niagara, Shenandoah, Silicon," on successive lines; then follow five vacant lines; next come "general scrap," "gate scrap," on separate lines, followed by three vacant spaces; and the last three lines are filled by "coal," "coke," "wood." The return shown on this form is entered on the monthly report sheet, and from this record the gross cupola cost of castings is established. Adding foundry pay-roll total and supplies-cost total gives castings production cost, charged to foundry, and foundry is credited with all castings received by stores room at a rate per pound fixed by above totals. The pound rate may vary from month to month; 5 per cent. is added to foundry pound rate for stores room value of castings.

Form 19. Fuel Record book; width of page, 9½ inches. Each page printed with bold headline, "Fuel Record," followed by "Name of Department using ....," and then a line of column headings; "Date Received. From whom purchased. Price at Mine. Freight. Handling. Total Cost. Per ton. On Hand. Date. Tons."

Fuel cost is a general operating expense, except where charged directly to blacksmith, drop forging, and foundry. The distribution of fuel is specified as far as possible, leaving little outside of power and heating to be charged to general expense.

Form 20. Handling Record. Size, 5½ inches wide by 6 inches high. Bold headline, "Cost of Handling." Second line reads:

Department..... Date..... 18 .....

Car initial.	Car No.	Date Rec'd.		No of Man.	Total Hours.	Rate per Hour.	Total Charge.
		Month.	Day.				

On this form is printed at the foot:

This blank must be filled out and fastened to invoices for carload lots or less if ordered, and signed by person in charge of unloading.....

This form is used to show direct charges arising from handling fuel, lumber, signal poles, and material in car-load lots. All other labor consumed in handling goods, either in receiving or distributing, is charged as unproductive, and all labor noted on form 20 is charged directly to invoice or production order, as the case may be.

Form 21, "Building Record," is used to register size, description, and value of all buildings included in the works, and contains original costs, and costs of renewals and repairs. Depreciation deducted at stated periods, making this form show present values.

Form 22. "Machinery Record." This form records the economic history of each machine used in the factory. It is not intended to contain an account with each machine, showing expenditures for repairs and renewals, as such charges are at present included in "unproductive labor and material," or else charged directly to machine rate per hour in prime-cost record. This form is a book, having pages 15 inches wide, headed in bold type: "Record of Machinery." The line of column headings is as follows:

No. Name of machine. Maker. From whom purchased. Date purchased. Purchase value. Weight. Cost of Freight and handling. Cost of installing. Total cost. Charged off for depreciation. Value. Date.

Form 23. "Shipping List." This form, when filled, is compared with the customer's order and with the production order, signed by the clerk making the comparison, and delivered to the superintendent's office. Size: small, 8½ inches wide by 6 inches high; large, 12 inches high. Headed "Shipping List"; second line, "Stores shipped by the National Switch and Signal Co." Third line, "Easton, Pa., ... 189....." The following five lines are:

Car No..... ..... Via.....
Car initial... ..... To.. .....
Order No.....
R. R. Order No.....
For Plant at..... Checked with R. R. order by.....

The column head line reads:

Description of Package. Quantity. Catalogue No. Articles. Value.

Form 24. "Pattern Record." The right-hand column of this form shows whether the prime cost has been charged against any specific order. If not, it is charged as unproductive labor to general expense. When filled, this form constitutes an important estimating reference. The page is 9½ inches wide, headed in bold type: "Pattern Record," followed by a line of column headings:

Description. Date made. Drawing No. Material. No. made. Follow boards. Flasks No. Flasks size. Cost material. Cost labor. Total cost. Charge to order No....

Form 25 is similar to form 24, and of the same size; pages headed in bold type: "Jigs, Dies, and Special Tools Record," followed by this column head line:

Description. When made. Kind of material. For what purpose. Weight. Cost of material. Cost of labor. Total cost. Charged to order No....

Form 26. Voucher. Size, 9 inches wide by 8 inches high. Printed on face as follows: first line, "Easton, Pa., ... 18..." Then

The National Switch and Signal Co.,

To..... Dr.....

18.... Address.....

The body of the voucher is ruled in a narrow vertical column headed "Key," at the left, containing the "Key" number of account chargeable, with adjacent dollars-and-cents columns; at the right are double dollars-and-cents columns; at the bottom:

Approved for payment

.....V. P. and Gen'l Mgr.

"I certify that I have examined all extensions, prices, and calculations, and find them correct, and have entered the account on the books of the company, and the same has not been previously paid. ..... Treas. and Pur. Agt.

Further below is the receipt form:

Rec'd ..... 18.., from the National Switch and Signal Company, ... $\frac{100}{100}$ dollars in full for above account.

(Sign here) .....

Note. The above receipt must be dated and signed by the party in whose favor this voucher is made, and returned to the TREASURER, THE NATIONAL SWITCH & SIGNAL CO., EASTON, PA.

This "Voucher" form is used to record all disbursements of cash, except for factory and piece-work pay-rolls. The distribution of disbursements is grouped under 24 general divisions, called voucher titles. These voucher titles are not shown on the ledger, but each receives a number under which all subdivisions are registered, and the ledger account with each subdivision is numbered with the voucher-title number. The voucher form is printed on white paper for the office, and on tinted green paper for the agents.

The "Key" to this voucher number shows the title and number of subdivisions under each voucher title, so that at any time the subdivision account can be determined by the "Key" number.

On the back of the voucher is the following, followed by blank lines numbered up to 35, with one double-ruled space for totals at the bottom:

Voucher No..... Check No.....
Favor of..... .....
Address..... .....
For.....
At.....
Month of ..... 18...
Amount $.....

General Distribution.	Key.	Amount.

1. Advertising.
2. Buildings and Lands.
3. Draughting.
4. Experimental.
5. Factory pay roll.
6. Fixture acc.
7. Freight.
8. Fuel.
9. General expense.
10. Hand tools and supplies.
11. Installation.
12. Interest and discount.
13. Jigs and dies.
14. Law.
15. Machinery.
16. Maintenance, Buildings, and Lands.
17. Merchandise.
18. Oil and waste.
19. Operating.
20. Patents and good will.
21. Patterns.
22. Petty Cash Accounts.
23. Rent.
24. Trading Account."

Form 27, "Pay Roll Voucher." This has the same distribution of voucher titles and subdivisions. Size: small, 12 inches by 9 inches; large, 12 inches by 18 inches; printed as follows:

The National Switch and Signal Co. Pay roll for ..... weeks, ending.....
Voucher No. .... Place ..... Sheet No...."

Then follows this line of columns:

Name. No. Dept. Rate per hour. Hours productive. Hours non-productive. Total hours. Amount. Reductions. Amount paid. Date paid. By whom received."

Then follow fifteen blank lines, numbered consecutively in small characters at the extreme right-hand and left-hand margins. The printing at the foot is in three vertical divisions, as follows:

I certify that the above mentioned persons were employed as shown, and that the respective amounts are due them as set forth. ..... Superintendent.
Approved for payment .... V. P. and Gen'l Mg'r.
Paid as shown above ..... Sec'y and Treas.

This "Pay Roll Voucher," form 27, has on its back the vertical column of key numbers previously given for the general voucher form No. 26. The "Pay Roll Voucher" must be signed by all persons registered thereon, wherever employed. Different tints of paper are used for factory and installation workmen.

Form 28, "Piece Work Pay Roll," is similar to form 27, the variation being in the line of column headings, which reads:

Name. No. Pat. No. No. pieces. Rate per piece. Total. Grand total. Deductions. Amount paid. Date paid. By whom received.

Form 29. "Voucher Register." This is a book, having pages 35⅜ inches wide, with this headline in bold type:

The National Switch and Signal Company. Vouchers registered month of ..... 189..

Then follows this line of column headings:

Voucher No. Check No. To whom issued. Date paid. Amount. Key No. Advertising. Buildings and lands, Draughting. Experimental. Factory pay roll. Fixtures. Freight. Fuel. General expense. Hand tools and supplies. (Fold | here.) Installation. Interest and discount. Jigs and dies. Law expenses. Machinery. Maintenance B. and L. Merchandise. Oil and waste. Operating. Patents and good will. Patterns. Petty cash accounts. Rent. Trading account. Total. Date voucher returned.

Form 30. "Address Slip." Enclosed with all vouchers sent out by the treasurer, for ensuring accuracy of address in returning.

With a system of minutely-subdivided cost-keeping, "estimating" becomes purely mechanical, demanding, instead of unusual powers of memory and foresight, only ordinary clerical ability. Here follow the totals of five consecutive estimates with their actual costs, taken at random from the file of contract synopsis cards.

Estimated Cost.	Actual Cost.
$2307.00	$2297.00
837.00	801.00
1606.00	1567.00
1521.00	1588.00
1153.00	1127.00

Each of these estimates includes installation of the plant sold; this installation is an out-door job, subject to variations due to soil, accessibility, and the weather. The installation cost is a matter of estimate,—a guess, founded on past experience; in most cases the installation estimate is high; in this one case it is low, thus showing the impossibility of accurate guess-work, even when the guesser has had large experience in the line which forms the subject of speculation.

The factory manager accustomed to "lumping" methods of cost-keeping, who has followed this paper so far, probably approves the accuracy attainable, but believes so minutely-detailed a system of cost-keeping impracticable, because of the clerical labor involved. Such a belief is excusable, since Mr. Hansel himself was in doubt as to the propriety of installing his system, after spending his spare time for a year in devising it, in consultation with President Thorne.

With a high pay-roll of something like 500 names, a large part of them outside of the factory, and with daily detailed factory reports, bi-monthly balance sheets, and monthly inventories, all of the cost keeping is done by one cost-keeper, one assistant, and a typewriter.

THE DARIEN GOLD-MINING REGION IN COLOMBIA.

By Eduardo J. Chibas.

THE region of Darien, extending from the Atlantic to the Pacific, forms the southeastern portion of the isthmus of Panama, in the Republic of Colombia. It was from this region, so full of historic interest, that Vasco Nuñez de Balboa discovered the Pacific ocean in September, 1513. Balboa obtained considerable gold from the Indians at that time, and, although he wrote to Spain that he had discovered in Darien more than thirty streams carrying gold, it was not till more than a century later that any attempts were made at gold mining. The quick returns, and the abundance with which gold was found as soon as mining was started, encouraged the Spaniards to brave the unknown perils of the virgin forest inhabited by warlike Indians, some of whom have, to this day, remained unconquered and still occupy and hold sway over a small portion of the territory. The early settlers were repaid for the untold hardships of travel and climate they had undergone by the discovery of the Espíritu Santo mine, in Cana, which alone produced more than $30,000,000 in gold.* This mine was successfully worked from 1680 till 1727, when a general revolt of the Indians obliged the Spaniards to be constantly on the defensive, and made it very difficult for them to continue operations. Matters were aggravated by the falling-in of one of the main galleries, causing the loss of several lives and hastening the complete withdrawal of the Spaniards from the gold region. No serious attempts were made to renew operations till a century and a half later, when an American company was organized with New York capital. They spent about $50,000 in opening a road and buying and transporting machinery, but, being unable to secure additional capital, they had to abandon the scheme in 1880, before any actual mining had been undertaken. The matter was again taken up in 1888, and, by the efforts of Mr. Hammersley Heenan, of Manchester, England, the Darien Gold-Mining Company was organized, in that city, with a capital of $1,000,000. Its object was to locate the Espíritu Santo mine, and to take up the work where the Spaniards had left off. Innumerable difficulties surrounded the enterprise at its inception. The mines of this region had remained untouched for nearly two centu-

* "Estudio sobre las Minas de Oro y plata de Colombia," por Vicente Restrepo. Bogotá. 1888.

ries. A forest had grown on the site of the old mining town, near Cana, which at one time must have been well defended, as in the ruins of one of its forts three brass cannons were found. Old workings could be seen in the beds of many streams, or near them, where the alluvial deposits had been worked. Remnants of old stone stamp heads and long and deep water ditches added to the evidence of the industry and activity displayed by the early settlers in that region.

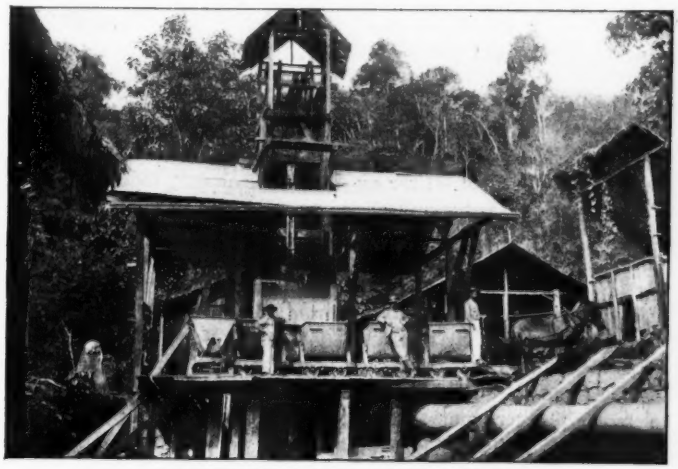
But the ancient records were somewhat confusing as to the exact location of the richest mine, and, in consequence, a few of the old workings had to be prospected to locate the one desired. The difficulties of transporting provisions and machinery were very great, as

PART OF THE TRAMWAY BETWEEN MINES AND MILL.
Showing Cana plateau, and Paca range in the background.

Cana is situated on one of the spurs of the Andes, at more than 2,000 feet above sea-level, with higher mountains, and a very broken country intercepting the way to the navigable portion of the Tuira river, which forms the natural outlet to the Pacific. A 10-stamp mill was erected in 1889. For many months the results were far from encouraging. The ore from what is known as the North mine proved of poor quality. No signs of the wonderful riches were yet in sight. The working capital was being rapidly exhausted, and doubts were beginning to enter the minds of the organizers of the company, when a happy incident caused a favourable turn in affairs.

In January, 1893, the prospecting shaft at the South mine struck old workings at ninety feet below the surface, and the water that had

accumulated in them rushed in and flooded the mine. Were these the old workings of the Espíritu Santo mine? To answer the question, new capital was subscribed, and the mine was drained by the construction of a drainage adit, consisting of a tunnel 1,100 feet long, opening on the hillside. This tunnel was finished in August, 1894. After the water drained out, extensive old workings were revealed. Some of the galleries had fallen in, and the extraction of any kind of rock was dangerous; so they had to proceed slowly and cautiously. To expedite the work, it was necessary to sink the Heenan engine shaft a short distance from the lode. At one hundred feet below the adit a cross-cut was commenced towards the ore-body, which was struck in December, 1895. A few days later the workmen again found



HEENAN ENGINE SHAFT, ESPIRITU SANTO MINE.

empty cavities. The Spaniards had evidently been farther down than had been supposed. Old implements and tools slowly came to light, —iron bars with steel points, hammers, remains of leather buckets, pieces of manila rope, wooden bateas about eighteen inches in diameter (probably used to carry the ore out of the mine), and six tread wheels (evidently worked by slaves for raising the water). Some of the wheels and many tiers of timbers were found in place and in good condition, after nearly two centuries of burial.

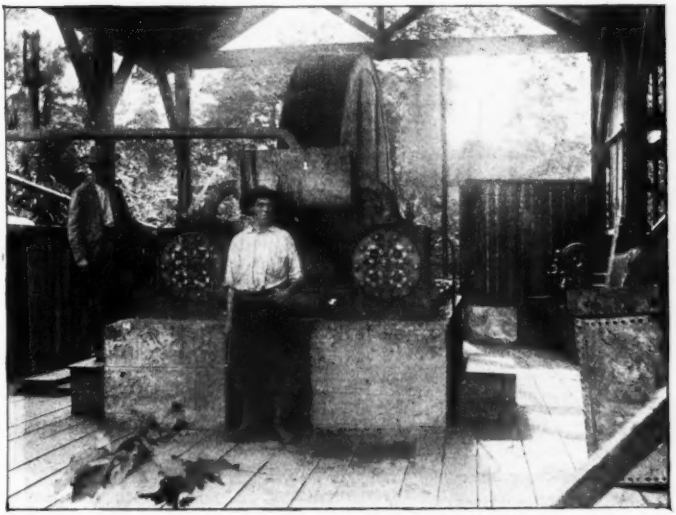
All the above findings agreed so closely with the description of the workings of the Espíritu Santo mine, given in the Spanish records, that no doubt was now left as to its identity, and the efforts

were directed to get below the Spanish workings. The engine shaft was continued to one hundred and eighty feet below the adit, making a total depth from the surface of three hundred and thirty feet. The cross cut was driven from this point, and reached the lode during the summer of 1897. This level seems to be below the Spanish workings; at least, no evidence has been found to the contrary. While the engine shaft was being sunk and the cross-cuts were being driven, mining was going on among the old workings, which have yielded during the last two years 10,528 ounces of gold, realizing in London £44,522.* The average value of the rock treated has varied from 1 to 1½ ounces of gold per ton. As all the mining so far has been confined to the portions that had been left thoroughly honeycombed by the Spaniards, who had undoubtedly removed the richest portions, a much larger yield is expected from the virgin lode which is beginning to be worked at the lowest level. The results so far achieved point to the full realization of expectations.

The lode formation of the Cana mines differs considerably from the ordinary ore deposit, and for that reason it is interesting from a geological point of view. The gold is associated with fragments, mostly of calcite, that fill the cavities in a volcanic rock,—andesite. These cavities do not seem to have measured more than a few inches in any dimension. The gold is mostly found around the outer portion of the material filling the cavity, and in contact with the enclosing andesite. The lode, at a depth of one hundred feet below the adit, or two hundred and fifty feet from the top of the engine shaft, is 80 feet wide and 120 feet long. At a point 80 feet lower it is 90 feet wide; sufficient work has not been done to determine its length.

The water is taken out of the mines by means of two Rittinger telescopic plunger pumps, placed at the present lowest level, one hundred and eighty feet below the adit and worked by two hydraulic motors, at the adit level, with which they are connected by steel rods. The two motors can be worked independently or together; likewise the two pumps. Their combined maximum capacity is 600 gallons per minute for a lift of 700 feet. The motors work under a head of 330 feet of water, which is conveyed from the Seteganti river by a ditch four feet wide and three deep, and six miles long, cut on the side of a steep hill. Many crossings of small ravines and creeks required the construction of 1,200 feet of flumes, built of 1½-inch planks and resting on trestles some of which are 15 feet in height. The grade of the ditch is fifteen feet to the mile. Its total cost, in-

* From the last annual report of Mr. E. R. Woakes, who has been manager of the Darien Gold-Mining Company for the last six years, and to whose energy and ability a large share of the success of the enterprise is due.

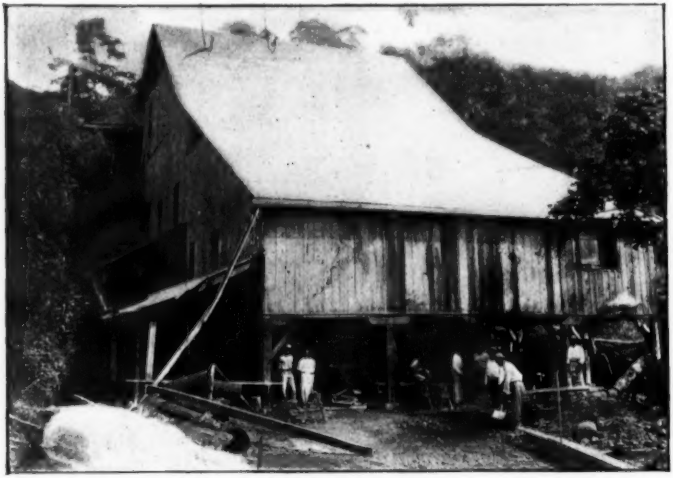


PELTON WATER WHEEL, DIRECT-CONNECTED TO AIR COMPRESSOR.

cluding flumes, flood gates, and overflows, was $24,000 in Colombian currency,—equal to about $11,000 in gold. The work was completed in fifteen months. The water is led by a steel-riveted pipe from the end of the ditch to the hydraulic motor.

Compressed air is used in the mines for hoisting, drilling, and operating a Cameron sinking pump. It is generated by a Schram duplex air-compressor, driven by a 14-foot steel water-wheel, constructed on the Pelton principle by Heenan and Froude, of Manchester, England. An unusual feature of this wheel is that it is mounted direct on the crank shaft of the compressor. It works under a head of 90 feet of water, which is brought from the Cana river by a ditch nearly three-quarters of a mile in length. Adjoining the compressor house is the machine shop, which is operated by a small Pelton motor wheel. A dynamo connected direct to this motor furnishes light for the shop, the compressor house, and underground.

The ore from the engine shaft of the Espíritu Santo mine is taken to the mill on cars hauled by mules over a tramway half a mile long. These cars are emptied into ore bins having a total capacity of one hundred tons, whence the ore is delivered by four automatic feeders to the same number of Fraser and Chalmers batteries of five stamps, weighing 850 pounds each. The ore is chiefly free milling, about seventy per cent. being extracted by amalgamation. The sulphurets



THE STAMP MILL.

are kept for future treatment. Recent experiments, carried out in Cana by a cyanide expert, Mr. G. R. Carey, show that the tailings are very amenable to treatment by that process, and a cyanide plant is now being erected. When completed, it is expected that the rate of extraction will be raised from seventy to nearly ninety per cent.

The stamp mill is operated by a six-foot Pelton water-wheel under a head of 96 feet, which is soon to be raised to 200 feet. The present ditch takes the water from the Cana river, and is half a mile long. The higher-level ditch will take the water from the same source, but will be two miles long. A continuous current dynamo, driven by a special Pelton motor, supplies electric light for the mill and principal buildings.

The company has erected a saw mill two miles from Cana. The power to run a 52-inch Hoe saw is furnished by a Leffel turbine under a head of 20 feet of water. This is conveyed from the Escucho Ruido river by five hundred feet of ditching. The timber is felled in the adjacent woods, and hauled out by oxen.

The installations awaken a feeling of admiration for the patience and perseverance of those entrusted with the work. Lack of a good road has been a serious drawback to the proper development of the mines; but, as soon as the workings in the Cana mine had proved the value of the property, it was decided to improve the unsatisfactory system of transportation that had so far prevailed. To carry out that

purpose, I was requested by the Darien Gold-Mining Company to proceed to Darien to report on the feasibility of building a railway, or a macadamized road if a railway proved beyond the means and requirements of the company. With that end in view I arrived in Panama towards the latter part of December, 1896, and at sunset one evening, shortly afterwards, I put out for Darien. At dawn of the next morning our sloop was sailing on the calm waters of the Pacific and passing close to the Pearl islands, so called on account of the large number of pearls covering the surrounding sea-bottom. The shells are secured by divers, who make a specialty of the work. Although the majority do not contain pearls, they are all valuable as mother-of-pearl. At the end of the second day we were entering the extensive gulf of San Miguel where the Tuira river empties into the Pacific and about one hundred miles south-east of Panama. While sailing on the majestic Tuira, at the mouth of which there are no bars to obstruct navigation, we were able to make headway only at six-hour intervals,—that is, while the tide was running in. The rest of the time it was necessary to anchor, to prevent the sloop from drifting back with the strong current caused by the outgoing tide. The swiftness of the current in either direction—due to the tide, whose effects are felt in a diminishing ratio for sixty miles up the river—will be easily understood when it is known that the difference between high and low tide in the gulf

OFFICE OF DARIEN GOLD-MINING CO., REAL DE SANTA MARIA.

of San Miguel is twenty-four feet. Being forced to these frequent stops, two of which were made in front of native villages, our progress was naturally slow. We passed swarms of alligators, some of them from fifteen to twenty feet long. On the fifth day from Panama we reached Real de Santa María, the end of navigation, more than fifty miles from the mouth of the river. Near Real de Santa María there can be seen the ruin of the old town built by the Spaniards in the sixteenth century, with the forts they used to defend it from the repeated attacks of the Indians and pirates.

On the morning after our arrival we started on the inland journey, and, after nearly nine hours of hard muleback riding, over marshes and rugged hills and among colossal trees, we reached Cituro, the half-way station, where the night was spent. To this point the Cupe river, one of the affluents of the Tuira, is navigable by canoes during the rainy season, when most of the cargo is floated up. The loaded canoes sometimes make the trip in four days, but often require more than double that time. In the dry season scarcity of water in the Cupe river, makes navigation more difficult, and the canoes have to stop three miles below Cituro. In the rainy season the return trip from Cituro to Real is oftener made by canoe than overland. The thrilling experience of shooting down a few rapids below Cituro, and the changing tropical scenes at every turn of the winding river, add novelty to this manner of making the return-journey, which takes from twelve to fifteen hours. The road from Cituro towards Cana

FERRYING ACROSS THE CUPE RIVER.
The tenth crossing, by the old road.

STARTING ON A CANOE JOURNEY.

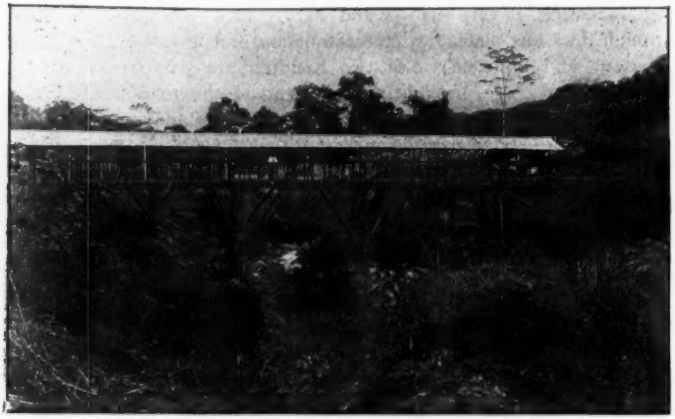
crosses the Cupe river nine times, and runs up the Cupe hill, which rises abruptly about five hundred feet above its foot. Thence up and down a series of smaller hills to the crossings of the Paca river; thence up the steep Paca hill, towering nearly a thousand feet above its base. After reaching the summit, a rapid descent of four hundred and fifty feet took us to the upper Tuira, so close to its source that the river, at the crossing, is very shallow and hardly fifty feet wide. A ride through the Cana plateau, a picturesque and fertile valley a few miles in extent, and a further rise of two hundred and fifty feet along the Espíritu Santo range, brought us to the end of the road at the Cana mines. All the ascents and descents over the Cupe and Paca hills were made on very steep and long grades, varying from 20 to 27 feet in 100 feet! It is not surprising, therefore, that the cost of transportation over these twenty miles has been more than $50 in Colombian currency—equal to about $23 in gold—per ton. The cargoes are mostly carried on the backs of mules or oxen, which take at least two days to make the journey during the rainy season. Wagons can be used only during two or three months in the dry season, when it requires the combined force of six mules and four oxen to haul one of them, with a load of only fifteen hundred pounds, over the mountainous portion of the road, at the slow rate of ten miles a day.

After a thorough investigation of the whole question, I reported against the construction of a railway or tramway for the present, as

PACK MULES CROSSING THE RIVER PIEDRAS.

the limited traffic would not warrant the expense, but advised the construction of a macadam road along a route which I selected, the covering of broken stone or gravel to be made six inches thick and about eight feet wide. Such a road, the construction of which is now well advanced, will make possible the use of wagons at all seasons of the year, and cause a great yearly saving to the company. While it can be built at a comparatively small cost, it will satisfy all the demands of the region for many years to come.

The difficulties of exploring were greatly magnified by the dense-



BRIDGE ON THE TRAMWAY LINE BETWEEN MINES AND MILL.

ness of the forest. We had not gone very far from Cana with our reconnaissance when we discovered that the Paca river and the upper Tuira run much nearer to each other than any one had supposed them to. As the distance between them grows less, so does the height of the portions of the Paca range separating the two rivers. This depression is so marked that we were able to cross the divide at a point five hundred feet lower than the old road. Had we begun the gradual descent to the Paca river, flowing four hundred feet below, as soon as we reached the summit of the new Paca Pass, we would have had to cross many gorges, or deep ravines, requiring the construction of high and long bridges; but, by locating the road along the hillside and keeping it

TRANSPORTING SECTIONS OF STEEL PIPE TO THE MINES.

at a uniform elevation for more than a mile, we obviated the necessity of these expensive structures, as the gorges were crossed so near their sources that they became mere ditches with small openings to bridge. The descent was made gradually, without crossing any of the deep ravines that run up into the mountain side. After reaching the narrow valley formed by the Paca river, we followed it till we came to the Paca cañon. At this place the river narrows considerably, and runs between two nearly vertical walls, rising several hundred feet in height. The hillside is so steep that, while trying to force a passage through the best portions, we had to walk in single file, treading carefully after each other, and in each other's foot-

prints, always holding fast to some near-by branches or roots to prevent an occasional slip from sending us to the bottom of the precipice. After carefully looking over the surrounding country, we discovered that at a point about one hundred feet above the river there was a break in the steepness of the slope, and through this section it was comparatively easy to locate the road. To overcome this height the line was raised gradually along the hillside from a point some distance back, and, after crossing the cañon, it was lowered in a similar manner. The maximum grade used in the new road is ten per cent., and this only at short and rare intervals. The greater portion of the road is on much easier grades, and presents a pleasing contrast with the long grades, having a rise of 20 or 25 feet in 100, in

THE STEAMER DARIEN.

the old road. The great expense and delays resulting from the sixteen crossings of the Cupe river by the old road from Cana have been done away with.

The improvements in transportation facilities have not been confined to overland. The little steamer Darien, with an elegantly-fitted cabin and capacity for twenty tons of freight, was sent out from England, and since March has been making trips between Panama and Real de Santa Maria in twenty hours. The sloops previously used took from four to twelve days.

While camping on the mountains, notwithstanding the fact that we were only eight degrees north of the equator, we found it necessary to use very heavy blankets at night, during the dry season from

ENGINEERS' CAMP ON THE PACA RANGE, 2200 FT. ALTITUDE.

IMPROVISING WATER-PROOFS FOR THE RAINY SEASON FROM NATIVE RUBBER.

January to April. The only disagreeable features of the region in that otherwise pleasant portion of the year are the unbearable *garrapatas** and the no less detestable *coloradillas*. Those minute insects infest the forests, and somehow or other find their way through the clothing to inflict a punishment much more severe than would be expected from their insignificant appearance. Their reign, however, is of short duration, as, after the first few showers of the rainy season, they completely disappear. Among other unpleasant visitors in those forests we found the big fly which produces the "*gusano de monte*." † This fly injects into the skin the germs of a tiny worm, which bores into the flesh. If not removed before it has gone very far, it will pro-

IN THE MACHINE SHOP.

duce serious complications. To the inexperienced the sore looks like a common abscess; but the natives recognize the true cause at a glance. After the application of moist tobacco for about half an hour, a slight pressure will bring out the worm. Without the use of that narcotic, however, no amount of pressure will make it loosen its tight grip. Black ants, growing to about an inch in length, are also common, and sting like a scorpion.

The wealth of Darien is not limited to gold. It is very rich in valuable timber, and a considerable amount of mahogany has been

* *Racinus hexapoda.*
† *Hypodermo boris.*

THE IVORY-NUT PALM.

exported. The palm producing vegetable ivory is very abundant. The rubber industry was also very profitable, at one time, but the natives' inexcusable practice of cutting down the trees, instead of simply tapping them to take out the rubber, has greatly diminished the output. In spite of this wholesale destruction, however, a day hardly passed while we were surveying through the forest that we did not see rubber trees. They thrive so well in that locality that their planting and cultivation ought to prove a remunerative investment. When the rainy season was approaching, we extracted rubber from some trees near one of our camps, and, by the use of a simple process adopted by the natives, we rendered water-proof all the ordinary cloth-bags that we had been using for carrying our clothing and instruments from camp to camp. We used them during the rainy season to our complete satisfaction. A coat treated in the same manner proved more impervious to water than the imported ones.

THE WORKING OF RAILWAYS IN MILITARY OPERATIONS.

By W. L. Derr.

"Go forth, my son, and see with how little wisdom the world is governed."
—*Chancellor Oxenstein to a young diplomat.*

IF recent events prove anything, it is that the great chancellor's words are strongly applicable to the present practice in military transportation.

It is strange, indeed, that the art of transportation has apparently been given the least attention by military authorities. In many instances the transportation of a large army has been left in the care of men almost wholly without knowledge of their duties. Stranger still is the fact that so little attention is paid to this important branch in the training of soldiers. Glance over the curriculum of any great national military school, and you will be surprised at the comparatively small amount of time devoted to the study of transportation,—and how little of that which is taught is of a really practical nature. As showing in a degree at least, how the practical side of the study of transportation as applied to railways is passed over in military schools, the writer recalls an accident on a railway near one of these schools. The road in question was blocked for a number of days by a landslide, and, though he was frequently on the ground inspecting the progress of the work, he did not once see any of the cadets there, nor could he find that any of them had visited the scene. Yet the work of restoring the line involved some of the most original and interesting methods of handling earth and of tunnelling known to modern practice,—just the kind of knowledge that should be acquired by an engineer, civil or military,—a knowledge applicable to many other undertakings than the opening of a railway line.

The transportation business, like any other profession or trade, must be studied carefully through a long apprenticeship, and he who engages in directing transportation without having served such apprenticeship is bound to bring disaster to the enterprise. The fact that men almost wholly without practical knowledge of railroading are sometimes placed in charge of a railway in times of peace is no reason why such men should be placed in control of a military line. In ordinary civil affairs about the worst a man can do is to lose money for his employers. In military affairs too much is at stake to warrant any experimenting. The building and operation of military roads should at all times be placed in the hands of men thoroughly trained in such work. The mere fact that a man has been, say, a suc-

cessful grocer, and has, in the course of his business, received a few hundred car-loads of goods by rail, is no argument whatever that he would make a successful railroad man, any more than that it is evidence that he would make a successful general in the field.

Undoubtedly railroads will always play a very important part in war operations, whether offensive or defensive. By their aid the long delays formerly incident to the bringing together of opposing armies will be obviated. These armies will arrive quickly and about the same time at the objective point,—that is, the frontier. The objective railroad points are naturally the large railroad centers, junctions, etc.; these will be strongly fortified, and will, no doubt, be points toward which attacks will be directed, because there, especially if in the rear of the army, will be placed the army supplies, etc.

The carrying of an army's supplies in the form of provisions is in itself a problem of great magnitude. When it is considered that at the best a region, no matter how fertile, cannot be counted upon as furnishing more than a few days, supplies for an army, it will at once be apparent that some means must be had for transporting additional supplies, and this means is generally a railroad. In a country where the railroads are built for purely commercial purposes, of course the best will have to be made of the situation as it exists; but, where railroads are built for strategical reasons, naturally their general direction will be toward the frontiers and to fortified places, and other important points, such as those where magazines and general supply and rendezvous stations are to be located, all of which points have, of course, been previously selected by the military staff.

Regarding the construction of a railway only the most general principles can be laid down. Local requirements and conditions must always prevail. The principles of construction—proper drainage, protection of the roadbed from the effects of running water, use of the best and heaviest material in the roadway, etc.—are so well known as to require no explanation. Heavy curvature or grades within reasonable limits should not be feared. It is much easier to use helping engines to overcome heavy grades than to materially reduce the grade in the construction of the line. Bridges should be of a strength a little in excess of actual requirements,—a fact to be borne in mind in designing the floor system and lateral bracing.

It is in the early stages of a war that great railway movements are made,—during the mobilization of an army and the forwarding of its equipment and supplies; and right here should be laid down a principle not to be deviated from—that all other than military business must be suspended over a line of railroad conveying troops and their stores to a point where there is probability of an early attack. In

other words, commercial interests must not in any circumstances be allowed to interfere with military movements of an important nature. Preferably the detailed movements of trains should be directed by the local civil organization of the railroads. There may be conditions under which it would be advisable to give certain operating officials military rank of a grade sufficient to ensure respect for their authority. But the instructions to such operating officials must be emphatic as to the priority of military over commercial movements. It is fair to assume that modern armies will—or certainly should—contain a sufficient number of technically-trained railroad men to at once take hold of, and operate if necessary, such of the enemy's railroad lines as may fall into their hands, and to do other work incident to the operation of railroads which it may not be advisable to entrust to civilians.

As train movements in America are almost universally directed by telegraphic communications, it is highly essential that the telegraph lines be carefully guarded and kept in a high state of efficiency. Moreover, the telegraph lines used in the handling of trains must not be burdened with other business, if the trains are not to be delayed waiting for their orders. Military men must bear in mind that frequently trains from one direction must meet trains in the other direction, superior trains must be run around inferior ones, and a thousand and one other details relative to the movements must be sent to the conductors and engineers in charge of such trains; and that therefore certain telegraphic facilities must be reserved at all ordinary times for the exclusive use of the train-dispatcher.

The organization, for operating purposes, of an American railway is by divisions, the ranking officer of a division being the superintendent, who is assisted by a trainmaster, a roadmaster or division engineer, a master mechanic, and a chief dispatcher, each of these assistants being at the head of a separate bureau. Speaking generally, the officers perform these duties: the superintendent is in charge of the division; the trainmaster ranks next below the superintendent, reporting to and in his absence acting for him, and has supervision over the trains and trainmen, and, in case of a wreck, over the wrecking; the master mechanic has charge of the shops, machinery, engine fuel, and mechanical stores, and general charge of enginemen and firemen when they are at headquarters. He is often assisted by a road foreman of engines, or traveling engineer, who rides upon engines and instructs the enginemen and firemen in the performance of their mechanical duties. The road master, or division engineer, has charge of the roadway, including the track, bridges, and buildings. He is often assisted by an engineering force, a master carpenter, master mason, and track supervisors, the latter having charge of the

track on a sub-division of the line. The chief dispatcher has charge of the train dispatchers, telegraph operators, signalmen, telegraph-line repairers, and signal inspectors, and of the distribution of power and cars. The train dispatchers, only one of whom is on duty at a time for a specified territory, issue orders in the name of the superintendent, for the movement of trains by telegraph. Dispatchers are on duty continuously—that is, one dispatcher does not go off duty until relieved by another, to whom the relieved dispatcher delivers a written summary of all train orders outstanding, as well as of other information necessary for his guidance. On some roads this arrangement of the duties of operating officers differs in the details, but in the main it is that found on the average American railway, and is the one best adapted for military lines, as responsibility is easily placed and difficulty arising from parity of grade is avoided.

The comparative slowness in the movements made by railroads in transporting armies and army supplies has often been caused by inadequate terminals, passing sidings, and signaling. It may be laid down as an axiom that the capacity of a railroad is the capacity of its terminals. In other words, trains cannot be run faster or more frequently than they can be made up and gotten out of terminal yards. Accordingly, if it takes, say, thirty minutes to switch a train and put it in shape for a return trip, that is the average headway on which trains can be run. In order, then, to get the very best results in train service, so far as concerns the rapid movement of troops, the movement must be practically continuous.

Generally the first move to increase the capacity of a railroad is to double, and even quadruple, the main tracks, without much regard to the expansion of terminal facilities. But, without a corresponding increase of the latter, there is practically no gain, no matter how much the main track facilities are increased. Even on European lines built wholly for strategical reasons this principle has been grossly violated. Yards are often arranged in such a manner that incoming trains must be held back while preceding ones are being switched. Of course, sites for the detraining of an army cannot always be selected beforehand. But it is fair to presume that railroads built primarily for military purposes will terminate at points where, under ordinary conditions, such detraining will take place. With proper block signal and braking appliances for controlling the movements of trains, the trains can be run with safety at two- or three-minute intervals, even at comparatively high speed. But, by the ordinary methods of the arrangements and working in yards, it will take at least ten times that long to get a train ready for a return trip, or out of the way of a following train. With the ordinary yard-handling of, say,

an army corps, it is only a question of a very short time when the yard will be filled to overflowing, which means that trains *en route*, when this occurs, must be held back until the blockade is raised.

The remedy for this is an arrangement of tracks that will permit of a continuous movement without breaking the train, except for the purpose of setting off, when necessary, a disabled car or engine, or to hold such cars as it may not be possible to unload at the moment. The circular or curved track, forming a continuous "head on" connection between the ingoing and outgoing main tracks, seems to be the only arrangement of track by which this situation can be brought about. With it a train, as soon as unloaded, is ready to proceed on its return journey.

In the operation of a military terminal the "interlocking machine" will be found almost indispensable, because this makes it possible to concentrate in the hands of one man the throwing of switches of a particular district, thereby obviating any loss of time from trouble arising through misunderstanding when more persons than one perform this duty. Of so much importance are these machines that every precaution should be taken to ensure the protection of the buildings containing the mechanism, even going so far as to armor them where they are exposed to fire. The simplest and easiest part of the movement of trains is their advancement when once clear of the terminal, just as a ship's greatest difficulty is to get out of the harbor or enter it. Once clear of land, the ship's movement is largely a matter of mathematics, until land is again sighted; so with a train: once out of a yard, it is easily handled, until it arrives at another yard. Open spaces for the debarkation are necessary for prompt movements,—a fact which was clearly demonstrated at the World's Fair at Chicago in 1893. There the Illinois Central Railroad conveyed 509,000 people in one day. In many instances these trains were unloaded before they were fairly stopped. But the passengers in this case were people of both sexes and of all ages, and much care had to be exercised in order to prevent personal injuries. With soldiers, the trains could have been unloaded without coming to a standstill.

The care and the distribution of power call for the most constant attention. In addition to the power actually used on the trains, engines should be stationed at points a few miles apart, so as to be available in case of the breaking down of an engine hauling a train.

The wrecking outfit should be immediately available, day and night, during heavy and important movements. In wrecking operations, the point to be aimed at is clearing of the track, regardless of damage to rolling-stock; no attempt should be made to pick up the damaged cars during the continuance of the heavy movement. It is

perhaps needless to add that damaged cars loaded with ammunition and other explosives must be handled with much care, and, when off the track, unloaded under the care of an expert, if one is available, before being moved. Wreckage must not be thrown on such cars, as a spark might be generated or other action caused that might set off the explosives.

The ordinary passenger car, with only end doors, is not so well adapted to the prompt loading and unloading of passengers as is a car with side doors. With cars having end doors, in loading and unloading passengers,—especially unloading,—each car should be made to take care of its own lading,—that is, the passengers should not have to pass from the platform of one car to that of another. Freight cars equipped with air brakes and Master Car Builders' standard couplers can readily be converted into passenger cars, as was done practically by the Pennsylvania and Illinois Central railroads during the World's Fair. The former company used the type known as gondolas, the side stakes being carried high enough to support the sides and roof.

The sides of the car were left on and the remainder of the side built upon them, the gondola ends being removed and ordinary box-car body ends, with doors, substituted. The Illinois Central equipment was of the standard box-car type, with side exits, similar to the open cars of street lines, the seats extending across the car. The sides of the car were carried to the roof at the ends of the seats. Where low station platforms are used, a step running the entire length of a car with side exits is of advantage. With the Illinois Central equipment, it was found that a train could be loaded or unloaded in a minute, and in many instances in less time when the station platforms were of the same height as the floor of the cars. It will be recalled that this traffic included many women and children,—passengers who had to be handled with greater care than it is necessary to exercise in transporting troops.

For the loading and transportation of heavy and unwieldy material, the rules laid down by the Master Car Builders' Association (see M. C. B. report for 1897) should be followed. Cars for this purpose should be carefully inspected before being loaded, and only those in the best condition should be used. In general, it may be said that lading bearing on more cars than one should be so placed that the weight will be distributed over the trucks as evenly as possible. The lading should have bearing near its ends only, so that the cars will "curve" freely, and, when loaded in cars with sides, it should be kept at least twelve inches from the sides by a single bearing on each side of the load at each end, placed opposite the bottom bearings. Very heavy guns require cars of special construction. A

car that was used recently for carrying a 137,000-pound cable for the Metropolitan Traction Company, of New York, which car was built by the Wabash Railroad, has four trucks of the ordinary diamond truck pattern, each pair of trucks being connected by equalizing bars, so as to form one truck, the sills and all other parts being very heavy. Through the spool upon which the cable was wound, there passed a heavy stick of timber, each end of which rested on heavy timber bents placed over the centers of the trucks. Such a car would carry heavy guns.

The handling and storing of explosive compounds is a matter which calls for much consideration. Mr. Henry S. Drinker, E. M., in his work on "Explosives, Machine Rock Drills, and Blasting," on page 93 says: "In warm latitudes, cool storing places are necessary, while in cool countries it is advisable to select only such places as will ensure a temperature of from 50° to 60° F. (10° to 15½° C.) being maintained. Cellars or sheds covered with earth prove the best in all climates. Particular cautions with regard to storage of gunpowder are hardly necessary; its characteristics, liability to ignition and consequent explosion, being familiar to all. With glycerine compounds, however, the fact is indubitably established that, when in good condition, they are absolutely non-explosive under ordinary circumstances, unless fired by percussion and heat combined, or under pressure. These compounds are only rendered liable to explosion by the presence of the caps or exploders; therefore too much care cannot be used in the storage of the two."

Such shipments should be packed in strong cases, preferably of a size and weight that one person can handle, and each package should be marked "Explosive" on top, sides, and ends. Nitroglycerine should be packed in an absorbent of some kind, to prevent leakage. Any package showing signs of leakage should not be loaded. The packages must be loaded bottom side down,—this on the supposition that the cartridges are so packed that they lie on their sides, not on their ends, when the packages are so loaded. The packages must be so placed in the car that they cannot in any circumstances fall. Percussion caps, exploders, fulminators, matches, and like articles, must, in no circumstances, be loaded in cars with explosives. Only cars in first-class condition should be loaded with explosives. They must be tight, with no openings through which sparks can enter. All cars that contain explosives should be labeled to this effect, on the outside, and also bear the admonition to handle carefully. Instructions for the handling of explosives, in the event of transfers having to be made, will no doubt be issued by the military staff, and should be placed in the hands of the railroad staff, including wreckmasters.

In loading heavy material the railroad-wrecking plant, especially the heavier types of steam derricks, will be found of great value. Many of these machines have a capacity of from twenty-five to fifty tons, and may be used in handling almost any class of military equipment, including the heavier guns. Field pieces will be loaded on flat cars and on gondola cars with low sides. If the latter are used, the ends should be removed, even though they are of the drop end pattern. The removed ends should accompany the cars to destination. In loading field guns, wagons, and wheeled vehicles in general, it has been found well to place a string of cars at the loading place and start the loading from one end, a portable incline being used to raise the guns, etc., to the floor of the car. Better still, at permanent depots, is a ramp or incline of earth at the loading end of the track and built on the extension of the line of the track. A team of horses, walking on the ground alongside the cars to be loaded, tows the guns, with towline attached to their sides, to the farthest end of the string of cars. "Gang planks" of hard wood or of metal are used to bridge the openings between the cars. Before loading, all the cars should be coupled, and, in addition, when necessary, chained together, with the brakes set up. In all cases, a rigid inspection of the cars should be made before they are placed for loading, special attention being given to the trucks, brake rigging, couplers, and sills.

A few words as to the destruction of railroads. It is certainly to be hoped that destruction of transportation lines will not be resorted to except in the most extreme cases. A railroad may be rendered inoperative, without doing much damage to it. By the removal of a few of the important members of the track, telegraph line, locomotives, and cars, the whole line may be rendered useless. There is nothing to be gained by the destruction of station buildings and shops. These play so little part in the immediate operation of a line as to make their destruction of no use.

The railroad employees, especially despatchers, signalmen, and trainmen, are recommended to keep a cool head when handling military business. If under fire, their chances of escape are much better if they keep their wits. Further, upon their coolness may depend great things. Dispatchers, particularly, must not get "rattled," if things near the front get a little "thick." Much may be going on there that cannot be grasped from the reports, which at the best are but general in character. It is usually safe to assume that the other man is doing pretty nearly the right thing,—that at least he is carrying out the general rules laid down for the handling of trains. Power and equipment should be kept well in hand, and the wrecking force where it is promptly available.

GREAT RAILWAY STATIONS OF ENGLAND.

By Thomas Cargill.

SO soon as the Great Central Railway, together with its diminutive brother, the Central London, and a few other minor relations, are opened for traffic, there will be, in round numbers, four hundred railway stations within the metropolitan radius of twelve miles. But a few can advance any claim to be included in the title of the present article. There is, therefore, no necessity for entering into superfluous details respecting the exact number of stations each main line can boast of, but it may be interesting to state the order of precedence among the principal railways having termini in the English capital. First and foremost there is the Great Eastern, next the London, Brighton & South Coast; then the South Eastern, to some extent its rival, followed by the South Western. The London, Chatham & Dover occupies the fifth place, pressed hard by the Great Northern, after which come the Metropolitan and the District, which might, in mathematical language, be bracketed. It is a little curious that the great London & North Western should be the ninth in the scale, and may be regarded as the last, since the remaining examples call for no particular mention. On the supposition that each of these four hundred London stations accommodated only the up-and-down traffic of a double-track of one railway company, they would still present enormous facilities for the transit and transport of passengers and goods. It will be readily recognised how greatly these facilities are accentuated, when it is known that as many as three and four companies use the majority of these stations. For instance, the terminal station of the London, Chatham & Dover railway at Victoria serves, in addition to its own line, the Midland, South Western, and Great Northern lines, which all run into it. Again, the Addison Road station, which is the joint property of the London & North Western and Great Western, accommodates both the South Western and the London, Brighton & South Coast railways. If therefore so many of the four hundred stations as are used by more than one company were credited with each separate service, or, in other words, multiplied by the number of the individual companies running their trains into them, they would reach a total of nearly seven hundred, instead of four hundred.

It has been more than once remarked by outsiders that one railway station very much resembles another; the statement perhaps is true of roadside stations. It must, however, be a very inobservant

traveller indeed, assuming that he were acquainted with the Euston terminus of the London & North Western, and with that of the Midland at St. Pancras, who could fail to perceive the widely-different distinguishing characteristics of the two stations.

All railway stations may be classed under one of three heads,—terminal, intermediate (or, preferably, through), and a combination of the two. It will be seen subsequently that this triple classification is susceptible of further subdivision, and that some stations which are generally regarded as belonging to the first type are not strictly faithful examples of it. As an instance, take the St. Pancras station, already quoted, which is unquestionably a terminal station for the lines connected with the Midland railway system. But it is not so for others. The city trains make a through station of it, and it is to provide separate tracks for these that the extensive widening of the Midland line at Kentish Town is at present in progress and nearing completion. In the third class may be included many junction stations, which, while acting as through stations for the main up-and-down traffic, are termini for the branch, or branches, running into them. When these latter are of short length, and consist of a single track, they are generally worked on the see-saw, or shuttle, principle. The Charing Cross and Cannon Street stations on the South Eastern railway, and that of the London, Chatham & Dover at Victoria, are, among others that could be mentioned, perfect examples of terminal, or dead-end, stations. The general arrangements of an ordinary double-track through station is represented in Fig. 1, in which the letters CP, SC, and CS indicate a cattle platform, signal cabins or boxes, and a goods shed, the rest of the diagram being self-explanatory. Communication between the two platforms is effected by means of a foot-bridge. Dotted lines show the centre lines of the road approaches, the principal thoroughfare crossing the line at AB, either on the level, or in the form of an over-bridge, or as a subway. For many years the first of these methods has been practically tabooed by the British public and the board of trade. In the country, where the necessary land can be readily and economically acquired for forming the approaches for an over-bridge, the erection of it constitutes the safest, most convenient, and, in the long run, cheapest of all means. Subways are absolutely inevitable in large towns, especially in connecting a high-level station with a low-level station. Perhaps the best-known example in London is the subway between the Metropolitan and the London, Chatham & Dover. It is a simple matter to keep these subways, which are so short, and, in addition, well lighted and constantly full of passengers, in proper order and under constant supervision. But the case assumes a very different aspect

when the tunnel is a quarter of a mile long or more, and the shades of night close in. Wretchedly lighted as they all are, they are a continual source of trouble and annoyance to the police, who are charged with the maintenance of them and the protection of those passing through them. So strongly do the Parisian police object to the building of *sousterrains*, on the score of decency and morality, that on the metropolitan and suburban lines which are intended to serve the great exhibition of 1900 the use of them has been vetoed, and foot-bridges are to be adopted instead.

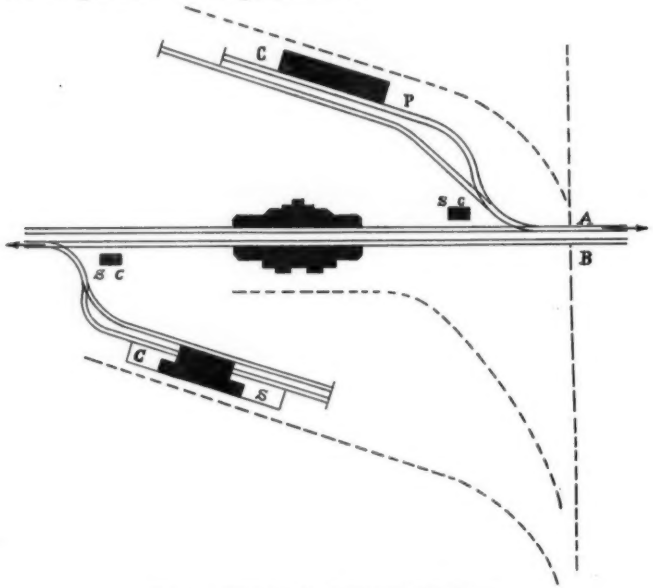


FIG. 1. DOUBLE-TRACK THROUGH STATION.

When a through station of the kind represented in Fig. 1 becomes a junction station, it follows, after the main lines of traffic clear the signal cabins, that several lines radiate from them in the direction of the different branches, thus giving rise to the French term of *gares de bifurcation*. There is one more instance which may be adduced, before passing on to terminal stations; it is shown in the diagram in Fig. 2, which is sufficient to elucidate the principle. A passenger travelling in the direction from A to B is desirous of reaching C. After traversing the proper distance in the direction of B, past the points at P, the train proceeds in the direction of C,—that is, toward

the traveller's goal. In a word, the train retraces to some extent its original course, and causes the passenger to do so also. Hence the French term for these stations, *gares de retroussement*, of which there are some very good examples at Marseilles, Amiens, Lille, and Orleans. If Waterloo terminus be supposed to be situated at A, Waterloo Junction being shown in black and lettered W. J., then the terminus at Charing Cross will be represented by C. Although a continuous single track is shown from A to B, and is laid, it is used only on special occasions. The passengers walk from the Waterloo terminus under cover to the Junction,—a very short distance,—and then entrain either for Charing Cross or the city.

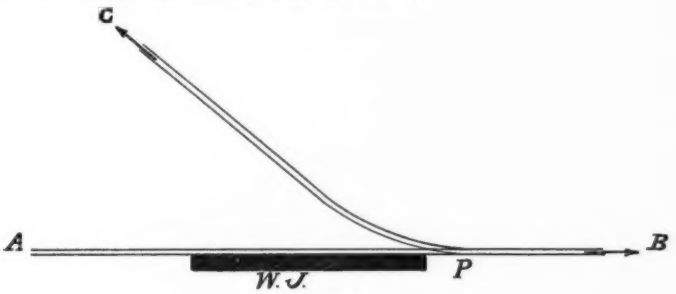


FIG. 2.

There are three ruling principles dictating the lines to be followed in the setting-out of railway termini. The first of these systems, more particularly observable in the older examples, is that in which the booking-offices, the waiting-rooms, and the other permanent station-buildings are arranged alongside or parallel to the departure platform. Under the second category may be classed all those stations which have these structures disposed at the dead end, and at right angles to the terminal tracks. A combination of the first two systems forms the third. A very good instance of the last-mentioned is the terminus of the London, Chatham & Dover railway at Victoria, in which the buildings and offices serving the main line are located in accordance with the principles of the first system, while those belonging to the local and suburban traffic follow the method adopted in the second. In future these three systems will be designated the parallel, the end, and the compound. The second of these can be employed in through stations. Such buildings must be placed either over or under the tracks. At Vauxhall, the ticket station for the Waterloo terminus of the London & South Western railway, the offices, with the exception of a couple of waiting-rooms, are all below

the platforms, thus obliging passengers to ascend and descend a long and sufficiently steep flight of steps,—although there is a lift for luggage. Again, at some of the large stations on the Metropolitan District railway the buildings are placed squarely over the permanent way, and the platforms are completely clear and unencumbered, save for a bookstall or two, and perhaps the slender columns carrying the roof. In both cases, the inevitable ascent and descent are present, and the transport of luggage is a troublesome and tedious affair. The large station at South Kensington is a good example of this class of

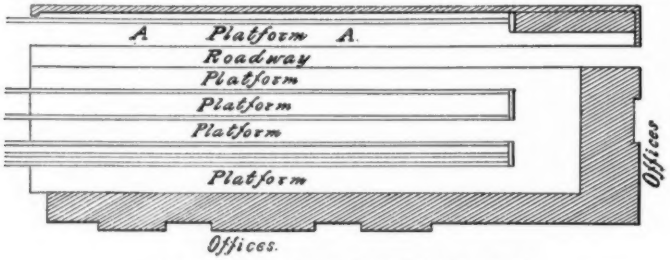


FIG. 3. TERMINAL STATION, COMPOUND SYSTEM.

structure. A sketch plan of a terminal station on the compound system is given in Fig. 3. It contains an extra platform, A, which allows trains carrying luggage from the continent and foreign countries to come alongside. Platforms similar to A in the figure, are frequently termed dock platforms, and invariably have a dead end.

Before passing to the description of the great stations of any particular main line of railway, there is one more general example which should be noticed,—island stations, or island platforms. These possess many advantages as through stations, especially when they act also as junctions for one or more branch lines. In this instance the offices, refreshment-rooms, and other conveniences are placed upon one broad platform extending across from one main line to another,

FIG. 4. ISLAND STATION.

and, if there are any branch lines, they run alongside a dock platform forming parts of the main one, as shown to the right of Fig. 4. Occasionally the booking-offices are placed on an island platform, but more generally either above or below it. If the station be on an embankment, the access to the platform from the booking-office would be

a subway, and, if in cutting, by an over-bridge, which might be restricted to pedestrian travel or not, according to circumstances. The allegation that foot bridges are exceedingly unpleasant and inconvenient to passengers is true, but it is not invariably the case that they form great obstacles to the moving of personal luggage. All platforms, or very nearly all, terminate by a short ramp, and the porters run their barrows up and down them and across the tracks without troubling themselves with either subway or bridge. There can be no question respecting the facilities which the island-station principle affords for traffic, and, since all the platforms, or, rather, parts of the same platform, are on the same level, the transference of passengers and their belongings from one train to another is accomplished with ease and rapidity. Besides, one range of station buildings suffices for the travellers by all the trains, and the working staff can be employed at a minimum of labor and expense. It may be mentioned that all the through stations on the Great Central railway from Annesley, ten miles north of Nottingham, to London,—a total distance of nearly a hundred miles,—are designed and laid out as island-platform stations. When running over the northern half of this new route to the metropolis, in June last, I was much struck with the excellent manner in which the service of the public and the railway company was provided for by the employment of these island stations.

TABLE.

Name of railway	Length of system in miles.
The Great Western	1,900
The London & North Western	1,700
The North Eastern	1,560
The Midland	1,310
The North British	1,080
The Great Eastern	1,020
The London & South Western	800
The Caledonian	710
The Great Northern	670
The Lancashire & Yorkshire	520
The London, Brighton & South Coast	420
The South Eastern	360
The London, Chatham & Dover	180

One of the largest and most important of the great railway stations in the British metropolis is that of the Great Western at Paddington. Like some of its contemporaries, "antiquity's pride it has on its side," and, although shorn forever of its splendid, but fatal, distinguishing characteristic,—the broad gauge,—it can still boast of the longest mileage of any railway in the kingdom. It also has

the longest stretch of line, the distance from Paddington to Penzance amounting to 324 miles, though this is closely approached by the London & North Western, with its 318 miles, from Euston to Carlisle, and also by the Highland service from Perth to Wick, a journey of 306 miles.

It is rarely that the absolutely necessary, or even a marginal, amount of land can be exactly obtained for the site of a terminal or a through station in London or in the large provincial towns; the consequence is that frequently a surplus area of ground has to be acquired, or what at the time was regarded as superabundant. This land in many cases has been sold, on the supposition that it would never be required, and yet but a few years afterwards it, together with the buildings upon it, has been repurchased at almost exorbitant prices. Assuming that a sufficient area has been obtained for an important terminal station, the configuration of it is a most important point. For, it must be borne in mind, the ground plan,—and here the engineer comes to the fore,—both in shape and size, must be utilised to the maximum, for the laying of the tracks, the arrangements of the platforms, and the general construction of the station, irrespective of all esthetical or other considerations.

A plan of the terminal station of the Great Western Railway at Paddington is represented in Fig. 5, from which it is evident that it is laid out on the first, or parallel, principle, as all the offices and buildings are located on one side of the station. It has a very expansive open space at the dead end, marked AA in the plan, measuring nearly two hundred feet from the buffer-stops of the tracks to the rear of the Great Western Royal Hotel. There are, in all, seven platforms, but, while four of these are single,—each serving only one track,—*viz.*, 1, 8, 9 and 10,—the other three are double, and serve two, one on each side, the tracks being designated in the stations as 2-3, 4-5, and 6-7, respectively. The Great Western terminus lies very snugly between two stations of the Metropolitan railway,—the one at Praed street and the other at Bishop's road,—and is connected with both by suitable subways and inclines. Four of the platforms, commencing with No. 1, are used as departure platforms, and the remainder as arrival platforms, although occasionally one or other of the latter fulfils double duty. Having booked himself to his destination at the ticket-office on platform No. 1, and supposing his train to depart from No. 2, 3, or 4, there are three routes open to the passenger by which he may get alongside, without incurring the penalty for "crossing the line." He may go *viâ* the foot-bridge marked FB in the annexed plan, or he may pass on to any of the platforms by walking along open space at the dead end, which communicates with

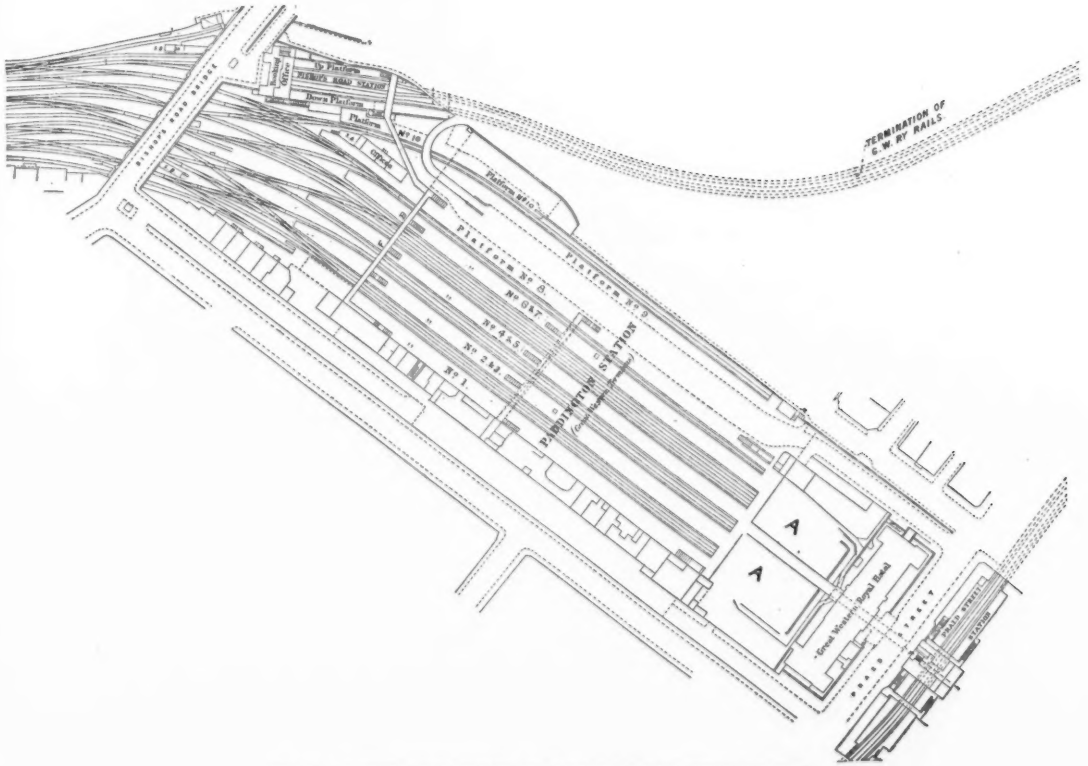


FIG. 5. PADDINGTON STATION, GREAT WESTERN RAILWAY, LONDON.

them all, in some cases through gateways. There is a third method of access, but it is available between platforms 1 and 2 only. It consists of a traveller, or portable platform, which, when not in use, lies concealed underneath the first platform. When in action, it is hoisted out, run across, and raised to the proper level, forming a level gangway, or small bridge, for the transit of passengers and goods from one platform to the other.

Between platforms 8 and 9 there is the usual roadway where carriages and cabs can pull up to receive passengers and luggage. The total length of the principal platforms is some 850 feet.

The parallel principle has one advantage, or, at least, what many people regard as such, although I think the point a doubtful one; at least one or two of the departure platforms are without barriers. This allows the friends of passengers to "see them off." An excellent proof of the confusion and delay caused by the practice is afforded by the scene at the departure of one of the Portsmouth, or other long-journey, trains, from the main line platform of Waterloo Station.

The covering, or the roofing in, of a large terminal station is one of the gravest problems that the engineer has to solve. The site of nearly every large station, whether terminal or through, presents physical features peculiar to itself, which call for especial treatment. The design and construction of the roofs of large stations is simply a question of columns or no columns. Is the roof to be in one span from side wall to side wall, or is the total breadth of the site to be subdivided into two or more separate openings? The real solution of this difficult question depends mainly upon two points,—the form and dimensions of the site, and the money available.

The Great Western terminus was commenced in 1849 and finished six years subsequently. The whole roof consists of three spans, and is carried partly on columns, and partly on the side wall of the offices and other buildings flanking the first platform. There are, therefore, a central span of 102 feet and two side spans, 68 feet each. The total length of the roof is 700 feet, and the breadth is 283 feet. The introduction of two transepts, each fifty feet wide with iron girders resembling groined arches, is the especial feature which distinguishes this station roof from all others in London. In general appearance the roof is very light; it is constructed of wrought-iron arched ribs, every fourth rib being rigidly connected to the cast-iron supporting columns. The two intermediate ribs in every bay are secured to open web girders running from column to column, the entire length of the roof. All the columns are bolted down to large masses of concrete, to give them sufficient lateral rigidity. The area of a station depends not so much on the absolute size of the roof spans as on

FIGS. 6 & 7. INTERIOR AND WEST FRONT OF PADDINGTON STATION, GREAT WESTERN RAILWAY, LONDON.

the total width, from side to side; and this dimension, in the example before us, is 283 feet, or just 43 feet more than the width of the St. Pancras station of the Midland railway. It is no wonder, therefore, that, in spite of the increase of traffic, the Paddington terminus is as nearly adequate to meet it, as are other examples built more recently and of far larger proportions. For instance, the Liverpool Street station of the Great Eastern line has a total width of 504 feet. The spans of the Great Western roof are very well chosen for an important terminal station, as they allow a very suitable and convenient subdivision of the available space. No more columns are introduced than are necessary, to avoid the use of large trusses, which are expensive, and, if heavy, detract seriously from the light and elegant appearance which should characterise structures of this sort. An elevation of the west front of the station is shown in the photograph in Fig. 7, with the ends glazed in. It is a little curious that, when the "Royal," originally The Great Western, Hotel was built, no tenant could be found for it. Some of the directors, unwilling that so fine a property should remain unproductive, constituted themselves a small company to lease and carry it on,—an undertaking which has met with all the success it deserves.

King's Cross station, the terminus of the Great Northern railway, like the station at Paddington, is laid out on the compound system, but the arrangement of the tracks is different. It is worthy of note that this is one of the few large stations in London or elsewhere which can be entered from the street-level without the necessity of surmounting inclines, or ramps, or climbing flights of stairs. There are five platforms, and between Nos. 1 and 2 there are no less than six tracks, with turntables for four of them. It is very seldom now that turntables are used for carriages, but they were very serviceable when the coaches were of the old short four-wheel pattern. The great length of the more modern carriages prohibits the use of any turntable, unless it be one some fifty-five feet in diameter, and large enough to take a full-sized engine and tender. Forty-six feet in length is a very ordinary dimension for bogie coaches. The cars for the Waterloo & City railway, just opened for traffic, are fifty feet long, and one of the Queen's saloons is more than fifty-six. It will be seen from the plan that, by means of its suburban station for local lines, which is altogether distinct from that portion of the terminus appropriated to the traffic of the main line, the Great Northern is in communication with the Metropolitan railway on one side, as it is on the other by a connection at York Road station. There is one feature pertaining to nearly all terminal stations,—the spreading out, or fantailing, of what might be termed the normal number of tracks, into many times their original total. In the example under notice, for

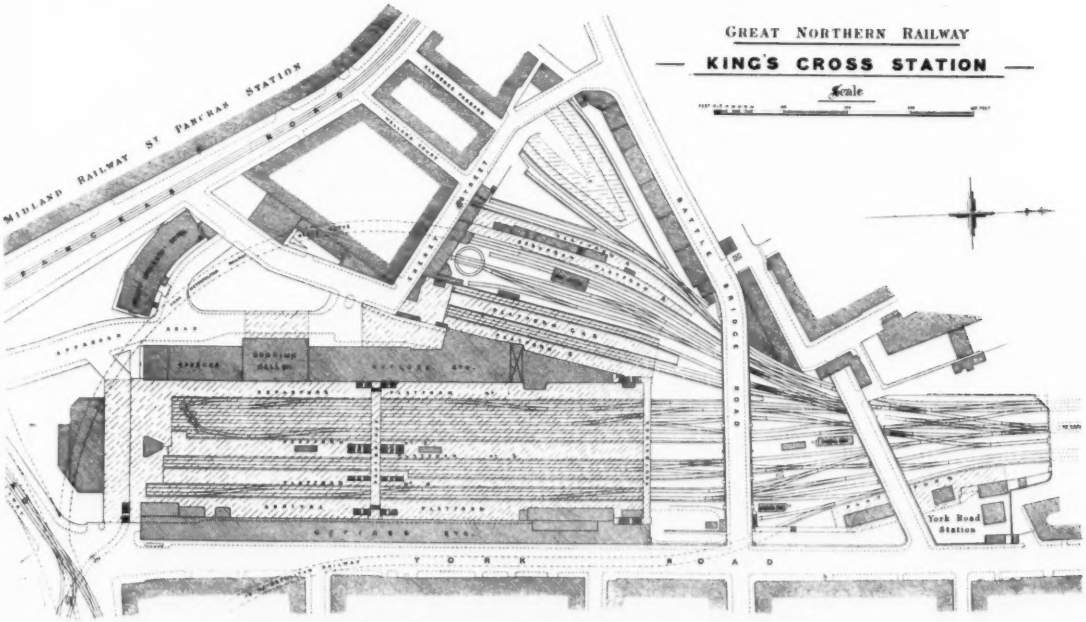

GREAT NORTHERN RAILWAY
KING'S CROSS STATION
Scale
MIDLAND RAILWAY ST PANCRAS STATION
P A N C R A S R O A D
BATTLE BRIDGE ROAD
York Road Station
Y O R K R O A D

FIG. 8. KING'S CROSS STATION, GREAT NORTHERN RAILWAY, LONDON.

instance, there are six normal tracks, which may be classified as two for the local or suburban traffic, two for that of the main line, and two for that of the goods. At the far, or dead, end of both stations, these six tracks spread out into no less than nineteen. At the Great Eastern terminus at Liverpool Street, the same number of normal tracks multiply into twenty-four.

From wall to wall the King's Cross station roof measures two hundred and twenty feet, and the whole breadth is divided into two spans, each of 105 feet. This measurement is exclusive of the smaller covered-in spaces and side entrances and approaches. The original roof of this terminus consisted of a pair of semi-circular timber arches of 105 feet span, constructed on the laminated principle introduced many years ago by a French engineer named de l'Orme,—a method

FIG. 9. MAIN DEPARTURE PLATFORM, KING'S CROSS STATION.

now obsolete. These laminated arched ribs were spaced twenty feet apart, and were built up of several layers of boards one and a half inches in thickness and screwed together. The boards were of various lengths, so as to break joints. The present arched ribs, erected some four years ago, are of iron, and rest upon the same side walls and pillars, as shown in the photograph in Fig. 9, which represents a part of the departure platform near the dead end and looking down the line towards the foot bridge. In Fig. 10 is given another view of the station in the reverse direction. There is a detail in the construction of the roofs of large railway stations which has not received the attention it

FIG. 10. DEPARTURE SIDE, KING'S CROSS TERMINUS, LONDON.

FIG. 11. ARRIVAL PLATFORM, KING'S CROSS TERMINUS. GREAT NORTHERN RAILWAY.

deserves. It relates to the subdivision of the total area of the roof into parts that admit light and those that do not. In a word, the diurnal lighting of a terminus is not by any means so much a matter of mere routine as it is usually considered. There are three methods generally employed for this purpose. The first is to place the sky-lights at and near the crown, or apex, of the roof, according to the design—arch or truss. The second is to distribute the glazed part along the sides. The third is to alternate the glazed and the opaque portions from the crown to the springings. It must be borne in mind that the object is not the concentration of natural light on any particular part of the station, but its uniform diffusion to every

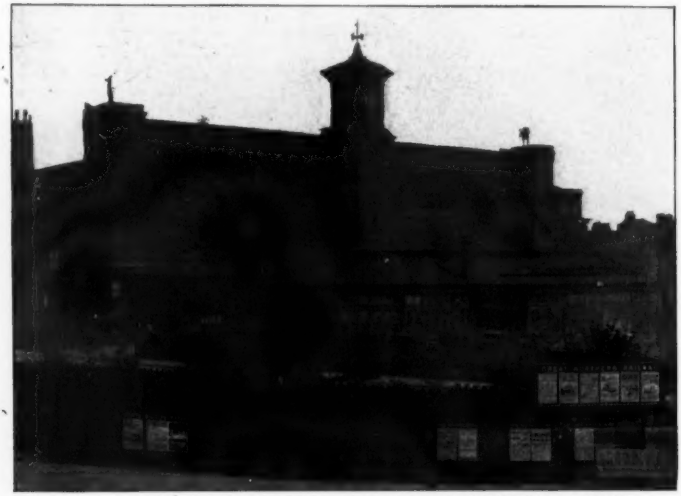


FIG. 12. KING'S CROSS TERMINUS, GREAT NORTHERN RAILWAY, LONDON.

part of it, so far as circumstances will permit. I should class these three arrangements as central, side, and alternate lighting. The two examples already selected belong to the first, or central, lighting method, and a glance at the photographs will show that the platforms and tracks in the vicinity of the side walls, and lying under the shadow of the unglazed parts of the roof, do not receive their fair share of light. Part of the arrival platform at King's Cross is shown in Fig. 11, and access to the separate platforms is had either by means of the footbridge, or, more conveniently, by passing round at the dead end of the terminus. An elevation of the end of the station looking on the Euston Road is given in Fig. 12; notwithstanding its

FIG. 13. DONCASTER STATION, GREAT NORTHERN RAILWAY. LOOKING NORTH.

imposing appearance, it is completely dwarfed by its gigantic neighbour, the Midland railway station and hotel.

The town of Doncaster, which can be reached by both the Midland and the Great Eastern lines, is an important station on the Great Northern system, as lines from Manchester, Leeds, and Grimsby run

FIG. 14. DONCASTER STATION, GREAT NORTHERN RAILWAY. LOOKING SOUTH.

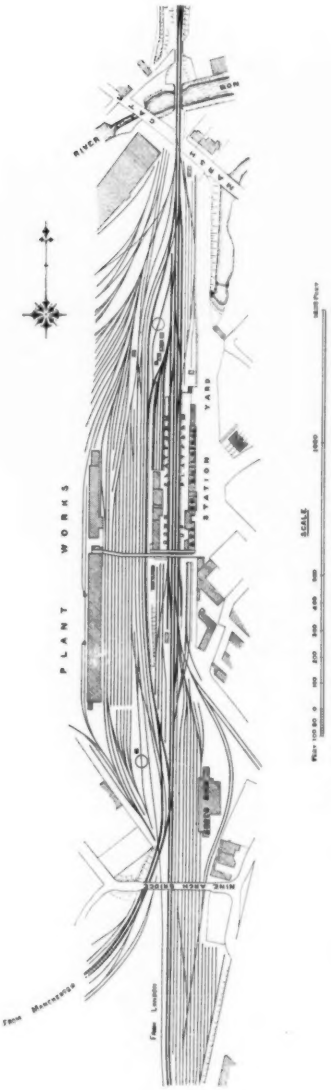


FIG. 15. GREAT NORTHERN RAILWAY STATION AT DONCASTER.

into it. It is a through, and essentially an island, station, as shown in Fig. 13. Between the up and down platforms there are six tracks, two in the open, and one of each of the remaining two sheltered by the roof covering the up and down platforms respectively, as clearly indicated in Fig. 13, which is a view of the station looking north,—that is, down the line. The outer columns supporting the roof must of necessity be placed on the formation level,—a somewhat unusual position, as it is preferable to put them on the platforms. In the latter case they may cause some inconvenience to the traffic, but there is no danger of either engines or trains coming into collision with them. The lighting is central, being over the platforms, where it is most wanted. The inner columns of the roofs are erected on both the up and down platforms shown in Figs. 14 and 16, and looking up the line. On the up platform the columns are in front of the booking-office and the other station buildings, and the intermediate space is covered in by a small roof resting on the main columns and the side walls. Upon the down side there is no small roof, an uncovered dock platform being provided for trains.

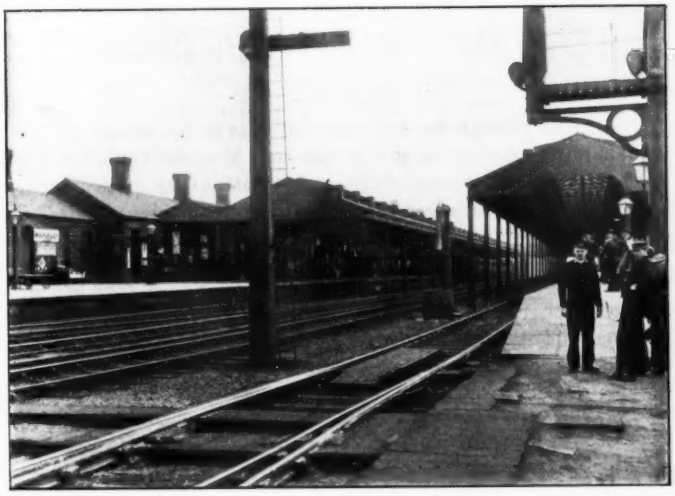


FIG. 16. DONCASTER STATION, GREAT NORTHERN RAILWAY. LOOKING SOUTH.

There are three general principles upon which the roofs of railway stations can be constructed. The whole area—that is, all the tracks entering and running through it—may be under cover. Again, some of them may and some may not. Thirdly, they may all be in the open.

As a rule, terminal stations must have continuous roofs, notwithstanding their heavy cost; but with through stations, especially when of moderate dimensions, the necessity is not so imperative. The Doncaster station roof belongs to the second type. At present there is a strong tendency to carry the third principle to the extreme, roofing in nothing but the platforms. It is alleged that, by the adoption of this method, considerable economy is obtained, and all the disadvantages attending the escape of steam and smoke in the station, instead of in the open air, are avoided. There is a good deal of force in these statements, for all engineers are aware of the serious and rapid deterioration, frequently the precursor of destruction, of all iron and steel work exposed to the corrosive influence of such agents. Anyone who has watched an engine brought to a halt underneath an iron bridge, and forced to remain there for some ten minutes, or perhaps longer, directing a continuously vertical fire of steam and other noxious vapours, under considerable pressure, against the structure, will cease to wonder why an extra thickness is given to the plates and bars of metal so ruthlessly attacked.

SEA-GOING RAFTS ON THE PACIFIC.

By Edward K. Bishop.

IF some ship-builder of old, with the lines of his primitive vessel in mind, could survey the oceans now, he would doubtless be as much amazed at some of the strange craft putting to sea from the Columbia river as at the modern warships or ocean greyhounds. In truth, many builders well acquainted with the present systems of marine architecture and engineering would view for the first time such craft, while the layman might hesitate before deciding whether to pronounce them monsters of the deep or some freak in ship-building. They can hardly be classified as ships, even though designed to go to sea, or as barges, though great freight-carriers; they are, in short, huge rafts, of round timbers or lumber, bound by cables, chains, and bolts in a scientific and ingenious manner, the method of construction having been evolved after many experiments in this little-tried field.

For several seasons past, rafts of logs have been towed to San Francisco, and the journey has been completed in safety a sufficient number of times to demonstate that the method of transportation is practicable as well as profitable. This year rafts composed wholly of lumber, and of totally different construction, have made their appearance, and every one interested in lumber or the carrying-trade on the Pacific coast is watching the experiments with great interest, as the establishment of this method of transportation would revolutionize the coastwise carrying-trade, and, by its great saving in cost, drive the sailing vessels and steam schooners out of business, or force a large reduction in charges.

Both log and lumber rafts are still looked upon as objects of curiosity on the Pacific coast, and more or less the projects of men who will take great risks. The former operates in a comparatively restricted field, and will probably never change existing conditions to any great extent, as many think the lumber raft is destined to do; but it has already stood the test of several seasons, and the methods of its construction will be treated first.

Ten years ago considerable attention was directed to the first raft of logs ever built for an ocean trip. It was towed from the Bay of Fundy to New York city. Since then, a number have entered that harbor, but at the present time the centre of activity in this line is on the Pacific coast of North America, where a company has been incorporated for the express purpose of transporting the timber of

Oregon and Washington to San Francisco by means of rafts. The problem of incorporating material as unpromising as round logs into a vessel sufficiently stanch to make an ocean trip of 650 miles is a peculiar one, and few have seen the actual work of construction.

In contrast to ordinary boat-building, the cradle for this unique vessel is constructed on land and launched, leaving the work on the raft itself to take place in the water. The usual process of launching a completed vessel is replaced by drawing certain pins, causing the entire cradle to separate into two parts and allowing the raft to float freely in the river. At a short distance it then closely resembles one of the modern whalebacks, without any upper works, though a little closer inspection reveals the corrugated surface formed by the logs and the huge chains encompassing the whole. The timber composing it is of fir, and is chiefly for piling purposes and spars. No sticks shorter than 30 feet are used, and many measure 110 feet.

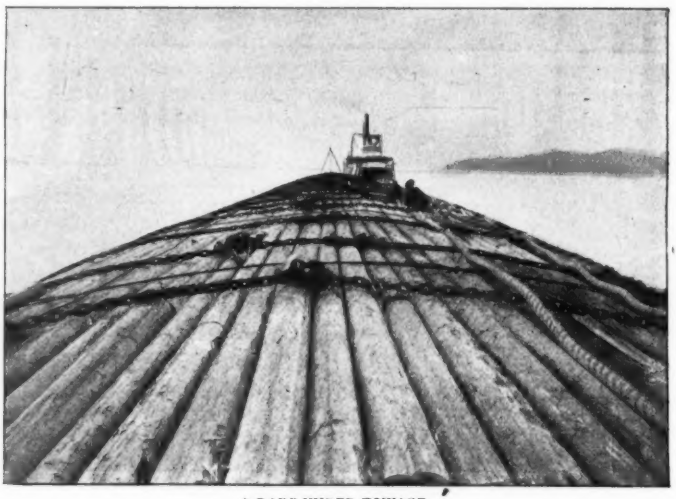
The cradle is composed of forty-three inverted bents, twelve feet apart, and the logs extend twelve feet over at each end, making the completed length 528 feet. The posts of the bents are 8 × 10 timbers; with caps, 10 × 20. The desired contour for the bottom of the raft is secured at each bent by 30° and 60° bearers, supplemented by gluts designed to produce a form as nearly circular as possible. The various bents are joined together longitudinally by a series of

A CRADLE IN PROCESS OF CONSTRUCTION, BEFORE LAUNCHING.

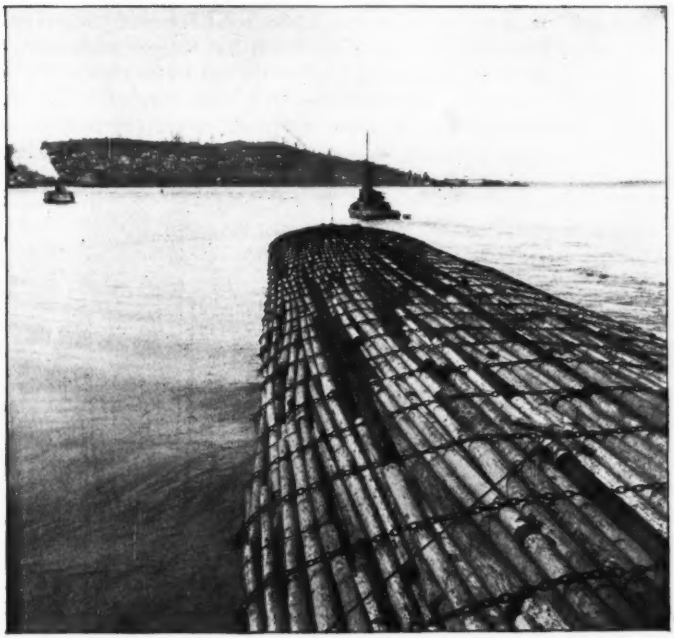
12 × 12 timbers, or waling,—six altogether, four being at the bottom and one on each side.

As already stated, the construction allows the final separation of the cradle into two parts, the line of cleavage corresponding closely to that of the keel of a boat. The division is rendered possible by the manner of joining the posts at each bent. One post is bolted to the 10 × 20, mentioned above, which extends the entire width at the point considered, while the other is fastened at right angles to an 8 × 10 and a 3 × 10, strapped together, with sufficient space left to allow the 8 × 20 to slide between, and long enough to reach half the distance between the posts. Thus it will be seen that the two sides of the cradle are entirely distinct,—the connection being made by sliding one timber into the channel formed by the other two,—and can be made into a rigid whole only by fastening the sliding member so that no motion is possible. This is done by pinning the three pieces together by a two-inch iron rod, so arranged that, when the raft is completed, power can be applied to withdraw each pin. Upon such withdrawal the cradle slides apart, releasing its burden.

When the cradle has been built and launched, it is towed to the desired location,—which in the Columbia has been in fifty feet of water near the mouth of a slough,—and is fastened in its place by a row of piling on one side, each pile passing through a tie box, connected with a bent, which allows the cradle to rise and fall with the tide.



A RAFT UNDER TOWAGE.



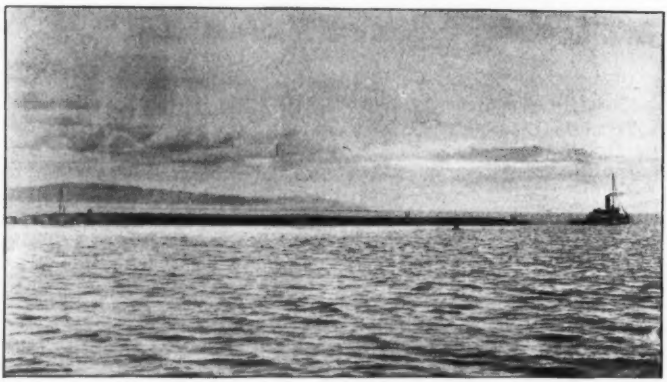
RAFT BEFORE ASTORIA, AT THE MOUTH OF THE COLUMBIA RIVER.

and also to sink deeper as the load increases. When completed, the raft draws about twenty feet of water.

In order to bind the raft together, the constituent piling must be very carefully selected. No swell butts or crooked sticks are accepted. The minimum length of a pile is thirty feet, and the butt must not be less than twelve inches or more than fifteen inches in diameter. Even with such timber, it is a source of wonder that a raft can be built to stand the ordinary swell of the ocean, not to mention the heavy seas frequently encountered, until it is noted with what care each piece is fitted into place, and the whole chained so that the pull on the towline actually binds it more firmly together. The logs are brought beside the cradle, where two large steam derricks, built on scows, are placed to hoist them into position inside. The raft grows, piece by piece, till the cradle is completely filled, when it is ready for the chain work which is to bind the whole together.

In form the raft closely resembles a cigar with each end cut off. It is designed that a section taken at any point should be a circle, but

in practice most of the upper face is somewhat flattened. Each end is a perfect circle, twelve feet in diameter, and the size gradually increases till the width is fifty feet. After the raft leaves the cradle, its shape is maintained by chains, made of 1¼-inch iron, encircling the raft at intervals of twelve feet, and by wire cables running both longi-



GOING OUT TO SEA.

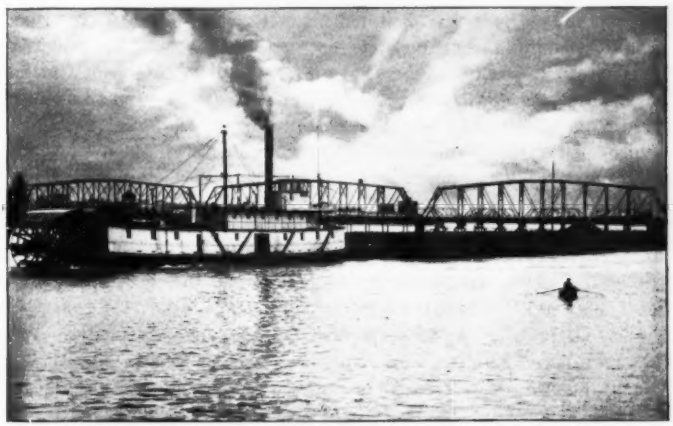
tudinally and transversely. The termination at each end is a stout bulkhead of four-inch plank, spiked to the ends of the logs. Outside of the plank are two upright round timbers, and the double cable, extending the entire length of the raft, joins the corresponding timbers together. The transverse cables connect the encircling chains a little below the water-line, thus preventing the raft from spreading.

The method of connecting the towline to the raft is ingenious and effective. Through the exact centre extends a heavy chain of 1¾-inch iron, with a series of smaller chains attached at regular intervals and connected by shackles to those encompassing the raft. Near the middle these chains extend at right angles to the centre line, alternately on one side and the other, except in the case of the last five at each end, where the circumference of the raft is rapidly diminishing, these being arranged in even pairs and slanting sharply toward the bulkheads at the ends, in a regular herring-bone plan, before joining the outside bands. Thus, when a pull is exerted on the towline, it is transmitted to every chain encircling the raft, and the heaviest strain will come on the rear end, which can better stand it. The logs can not escape, as they are bound by the circles of chain and the increasing diameter of the raft exactly as are the staves of a barrel when an attempt is made to draw the hoops over the centre. The amount of chain used is about eighty tons.

The completed raft contains 450,000 lineal feet of timber, or in the neighborhood of 3,000,000 feet, board measure. The average length of the piles is 55 feet, and the average diameter at the butt 14 inches. The spars are of special dimensions.

Auspicious weather is almost essential to a safe voyage of one of these unwieldy rafts, and they put to sea only at a time of year when storms are infrequent, though they successfully pass through weather much heavier than any that one would expect them to survive. In tow of an ocean steamer, the trip to San Francisco is made in about seven days. Several rafts have been taken out of Gray's Harbor, Washington, and this year will see the fifth start from the Columbia river. The first raft, in 1894, encountered a severe storm and went completely to pieces, but the succeeding ones reached their destination safely.

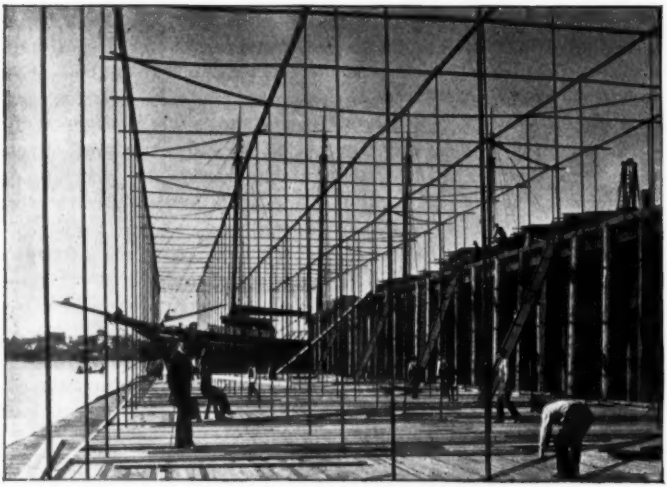
The shipping interests would gladly see the business discontinued, as there is always danger of several thousand logs being released on the face of the ocean,—a great menace to the safety of vessels whose course lies in their vicinity. The risk which the owners assume when they put many thousands of dollars into such a venture will be more



LUMBER RAFT LEAVING PORTLAND, OREGON, IN TOW OF A RIVER STEAMER.

potent in keeping the number of rafts from becoming large than the fears of captains; but the method of transportation is so economical that doubtless considerable quantities of the piling used in the neighborhood of San Francisco will find its way there in this form.

Captain Robinson, who was interested in the first raft of logs built on the Bay of Fundy, and who is in charge of those constructed on



ARRANGEMENT OF BOLTS AND METHOD OF PLACING LUMBER IN RAFT-BUILDING.

the Columbia river, has patented his methods of building the cradle and of placing the chains.

The first raft of lumber built to make the sea journey to San Francisco was constructed at Portland, Oregon, by Inman, Paulsen & Co., and left the Columbia river June 24, 1898, in tow of two tugs. It encountered a storm, and the wind, blowing at the velocity of seventy miles an hour, finally produced a sea which broke the raft in two. The fragments held together for two hours after the back of the raft had been broken, and finally one tug towed the forward part into the harbor of San Francisco, while the other succeeded after a time in picking up the remaining portion and towed it to the same port in safety. Only a tenth of the lumber was lost.

R. D. Inman, who accompanied the raft to study the action of the sea upon it and gain ideas for improving its construction, is convinced that lumber rafts can easily be built to endure any but the severest weather. The proprietors are not in the least discouraged by this partial failure, and at the present writing a second raft is well under way. With auspicious weather there is no doubt that the journey will be made in safety.

The raft which started in June contained 5,000,000 feet of lumber, and was 396 feet long by 53 feet wide. It is difficult to realize the immense quantity of material incorporated into this raft, though a comparative idea may be gained by considering the fact that the

average capacity of large ocean-vessels is little more than 1,000,000 feet.

Portland already has the distinction of loading the largest cargo of lumber that ever left the Pacific coast, which was won last year when the Glenlochy took 3,000,000 feet of railroad material to Siberia. Now, to pile Pelion on Ossa, the new rafts appear.

The idea of shipping lumber in this way originated with Johan Paulsen, a prominent lumberman, whose attention was attracted to the subject last winter by the difficulty of securing vessels to take lumber to San Francisco, owing to the fact that the majority of those available had entered the Klondike and Alaska trade. Doubters scoffed at the idea of transporting lumber in such a form, but the long years spent by Mr. Paulsen in the lumber business had included experience in rafting on eastern rivers and lakes, as well as on the Baltic; so, after looking at the project from a scientific standpoint and carefully considering all the difficulties connected with it, he concluded that a method of construction suited to an ocean trip of seven hundred miles could be evolved.

The raft projects very little above the surface of the water, and this greatly increases its chances for a safe trip, as the waves wash completely over it, encountering little resistance instead of expending their force in battering it to pieces. This is a principle used in the construction of the famous whalebacks, and one which experience has proved to be valuable.

The first step in constructing this late arrival among the various types of marine architecture is to select a dock, or drive a line of piling, four hundred feet long, as the basis of the work, and to supply a straight edge for the side of the raft. A stringer, or what might be termed a keel, is built for the entire four hundred feet by fastening together five layers of two-inch plank with ends butted so as to ensure the greatest strength. Five of these stringers are made, and placed something like huge joists, ready for a floor, and are then planked over crosswise, making an immense platform 396 feet long and 53 feet wide.

The bottom of the raft is now made, and the next step is to pierce each stringer, or joist, at intervals of twelve feet, and insert a long and heavy wrought-iron bolt, fitted with washer and nut below, certain planks being left loose up to this point, to allow their adjustment. The platform, which at first looked like a large dancing-floor, is now so changed as to resemble an orchard with long rows of spindling trees. The purpose of these rods can be seen after the lumber is put in.

First, a layer of lumber is placed lengthwise; next, another cross-

wise; and so on, till a pile twenty one feet deep is made, the raft gradually sinking as the load becomes heavier, and about a third projecting above the surface all the time. The rods serve to connect the bottom and top, and bind the mass into a homogeneous whole.

A very liberal factor of safety is allowed, as the aggregate strength of the 170 rods would support a weight of 25,000,000 pounds, while the weight of the completed raft is only 15,000,000 pounds out of water, and much less when submerged.

The completed raft is encircled lengthwise by a 1¼-inch cable, to furnish a secure hold for the towline. The cable is of plow steel, and its strength is equivalent to that of a 14-inch hawser.

Before construction was commenced, a prominent marine underwriter was approached in regard to insurance. He admitted that the danger of loss was not nearly as great as many people would suppose, but predicted that the promoters of the project would encounter difficulty in insuring the raft, because it is so radical a departure from the orthodox methods of transportation, and because, if successful, it would have a far-reaching effect upon the lumber-carrying trade on the coast.

Mr. Paulsen has applied for patents on his novel lumber carrier, and he expects his raft to occupy a place beside the whaleback, which was at first an object of ridicule.

An important feature in the construction of the raft is that only an insignificant percentage of the lumber is injured by nail- or bolt-holes, and even this can be utilized for firewood in California.

One of the principal objections brought against rafting is the probable staining of the lumber by immersion in the muddy current of the Willamette river and the salt water. Many claim that the concession in the price of the lumber which will have to be made on this account will balance the saving in freight charges, and say that at best only low-grade stuff can be so shipped to advantage.

Rafting of this kind is still in the experimental stage, and it is early to predict the ultimate result; but, as this method of transporting lumber is only about half as expensive as the old, it is safe to assume that there will be a strong effort to make it a permanent success, and that the lumber trade of California and the Pacific northwest of America is likely to feel the effect of sea-going rafts.

THE EFFICIENT USE OF STEAM AND LABOR IN ISOLATED PLANTS.

By Percival Robert Moses.

PRESUMABLY every one knows what "efficient" means by itself, but, when it qualifies other words, its significance is not always clear. Nine engineers out of ten will say that a plant is highly economical and efficient if it has a compound engine, or pump, or both. Frequently, however, such a plant is of little efficiency. Efficiency in the operation of a plant depends more on the proper arrangement of the parts and the distribution of their work than it does on the correct design of the separate machines. It will approach a maximum when all the parts are economical, and when the waste of fuel energy and the fixed charges of capital and labor are reduced to a minimum. This, like most truisms, is understood, but seldom applied. It seems as if, with economical parts, little fuel-energy would be wasted, but further consideration shows that such is not the case. For example, the best central-station plant equipped with high-pressure water-tube boilers furnishing steam to expensive triple- or quadruple-expansion engines, directly connected to generators of the most modern design, and with feed-water heaters, economizers, condenser, etc., utilizes less than one-third of the heat energy transmitted from the coal to the steam, the remainder being lost in the latent heat of the exhaust steam; while an isolated plant with a small fifty-h. p. engine using low-pressure steam in single cylinder only, with no condenser or expensive appliances, will, with a correctly-designed heating system, utilize more than seventy-five per cent. of the heat energy during a large portion of the year, and show an average percentage for the whole time greater than that of the central-station plant. It is the old Roman parable of the patricians and the plebeians—the belly and the members. They may be the best of their kind, but they are worthless unless they work together. To carry out the comparison with the human plant, the stomach may be considered as the boiler, the heart as the engine, and the other organs as corresponding to the laundry, ice, elevator, and other incidental machinery, neglecting for the present the closer identification of the parts. Nature is a remarkably efficient operator, and in no case do we find several stomachs supplying a number of hearts, each in turn supplying a separate organ; on the contrary, a single source pumps blood to all the organs. Each entity has a complete plant, but each plant

is centralized. In the same way, in a machinery installation there should be one source of energy and one apparatus for transforming and transmitting the power, and all the operations pertaining to the building should be supplied from this source.

Mr. White, in the transactions of the American Society of Naval Engineers and Mr. Shepard, in THE ENGINEERING MAGAZINE for May, have brought clearly to notice the almost incredible waste due to the multiplication of small prime movers, or engines, on board the modern warship, and Mr. Stanwood, in the same number of the magazine, in his discussion of the "Economical Use of Steam in Non-Condensing Engines," shows the futility of attempting economy where a number of separate small engines are supplying widely-varying loads. Many American hotels are shining examples of conditions more wasteful than those aboard ship. In these we frequently find gas used for lighting some floors, and electricity for lighting others, both being bought; ice and refrigeration are also purchased; steam is obtained from boilers for running wasteful steam pumps, for elevators and water supply, laundry engines, tool engines, kitchen engines, and engines for every little thing that has to be turned, each one seemingly more hungry for steam than the other. In addition, attempt is seldom made to use this steam after it has passed these engines, but more high-pressure or reduced-pressure steam is used for heating the house, the dry rooms, and the steam cookers. If these are the facts, what do they mean? They mean that the hotel owner, with a plant of the sort described, is burning twice the coal in winter that he should; that, besides paying the wages of his own engineer and assistants, he is also paying his share of the wages of the ice company's engineers, of the electric company's engineers, of the gas companies' engineers and their assistants, of their profits, of their rents and taxes, and of their other expenses, which together amount to more than ninety per cent. of their total cost and of their several coal bills, which, as they do not "use their steam efficiently," are each larger than his would be if all the functions were combined in one plant. This system is evidently wasteful, and the remedy must be present.

Briefly stated, it is, in my opinion, that efficient and economical operation of a plant can be obtained only when all the supply-functions possible are combined and the power for their working is derived from a single source. A concrete case will show the meaning clearly, and, as that of a hotel is the most general in its character, it will be first considered. In a hotel the supply-functions are light, heat, power, refrigeration, and ice. Light is needed continually in the kitchens, laundry, store-rooms, offices, halls, and restaurants, and at

night in all of these, except the laundry and store-rooms, and in the sleeping-rooms as well. Heat is used for warming the building, for the drying rooms and ironers, for kitchen purposes, for warming the water used to feed the boilers and that used for house purposes, and for local applications, such as curling irons, chafing dishes, and similar apparatus. Refrigeration is required for storage of provisions, ice, ice cream, and water. Ice is used for restaurant and bar purposes. Power is necessary for elevators, laundry machinery, tools, polishers, dish-washers, water pumps, and fans. All these functions should, if possible, be combined and supplied from a single source.

In the present state of the art, steam is the only means we have of supplying all from a single source, economically; gas will supply them all, but at an intolerable cost. To obtain the steam, coal will be burned in the fire-box of a water-tube boiler, generating steam at a high pressure. This steam should contain more than seventy per cent. of the heat energy liberated from the coal during combustion, and must be used at least three times, in order to extract these heat units and prevent waste. The primary use is to furnish power,—*i. e.*, to run an engine, utilizing from ten to fifteen per cent. of the energy and reducing the temperature of the steam to about 212°. This engine drives a dynamo, which in turn supplies power for the scattered apparatus above mentioned and for the refrigerating machinery; "high potential" electrical heat for irons, broilers, chafing dishes, and local applications; and—what is really the same thing—electricity for lighting. It may be said then that fifteen per cent. of the steam energy is used for light, electricity, and power. There remains to be furnished the heat required to warm the building, the dry rooms, the cooking apparatus, and the water. This heat, which has been aptly classed as "low potential," is obtained in greater part from the steam which has already done its first work in furnishing power. The secondary use of steam is, therefore, for warming, and, as more than sixty per cent. of the total heat received by the steam from the coal is used in this portion of the cycle, the importance of avoiding waste of opportunities for its use is obvious. The third use of steam is to become hot feed water for the boilers or water for ice-making. By the third and last operation the heat units remaining are returned to their original source, in the case of the feed water, and the cycle is completed.

Thus far the uses of steam only have been touched on, but the reasons for the divisions outlined are of importance. Steam, in its three stages of high and low pressure and hot water, has different potential capacities. At high pressure it can furnish heat and power, but at low pressure it can furnish only heat. It is manifestly inad-

visable, therefore, to use, for the lower grade of work, steam capable of producing power. Steam at low pressure can heat, to the highest temperature at which it may be pumped, four to five times its weight in water. It is, therefore, wrong to use the low-pressure steam where hot water will serve, unless the heat given off by its condensation is usefully employed. These are the general principles; necessarily they are subject to modification in particular cases. For instance, for dry rooms, steam ironers, and similar apparatus, a temperature higher than that available with low-pressure steam is required, and the practice is common of using reduced-pressure steam direct from the boilers.

This is unnecessary and inadvisable. Better practice requires that the exhaust or low-pressure steam should be used, supplemented by high-pressure steam from the boilers, the combination giving the desired temperature. There are several similar compromise points, which need not be mentioned. This statement of the cycle of steam is presumably an old story to many, but it must be borne in mind if the importance of the general statement is to be realized.

Another factor of great importance is the influence of climate. In New York there are about seven months in which house-heating is necessary; during the remaining five the exhaust steam may be used for other purposes. The necessity of combining all the supply-functions possible will now be apparent. In the ordinary city hotel the required supply divides between winter and summer in about the following proportions. Steam heat; winter, 88%, summer, 12%; light, winter, 66⅔%, summer, 33⅓%; refrigeration and ice, winter, 40%, summer, 60%; laundry steam, winter, 55%, summer, 45%.

The proportionate amount of power required by each of the supply items varies largely with the character of the hotel. The following figures, obtained by comparison and elimination from eight hotels similar in character, will serve as an approximation. The hotels taken were those of the old-fashioned type. The modern tall structure will probably show larger percentages for light, elevator, and refrigeration, and a smaller proportion for the laundry, while the heating factor will be negligible. The proportionate amount of power allowed for light was obtained by multiplying the number of lamp hours by .6, thus approximating the amount of coal necessary to supply light from a private plant. This table shows the percentages of the total annual power used by each factor in each season and in the whole year. For instance, the light requires 18 per cent. of the total power,—12 per cent. in winter and 6 per cent. in summer.

	Winter.	*Summer.*	*Yearly.*
Light	12.00	6.00	18.00
Heat	13.50	1.30	14.80
Elevator	6.00	5.50	11.50
Refrigeration	6.00	9.00	15.00
Auxiliary Cooking	1.50	1.20	2.70
Laundry, kitchen, house-pump, etc.	21.00	17.00	38.00
Per cent. of total power used	60.00	40.00	100.00

I have not divided the laundry from the kitchen, etc., it being impracticable to do so, but a ratio of $\frac{3}{5}$ to $\frac{2}{5}$ would not be far wrong. The large proportion required for refrigeration and ice is a little surprising, but the steady character of this factor causes it to almost equal that of lighting in power-consumption.

The exhaust steam from the electric-light plant suffices for steam heating and for heating the feed water in winter, leaving the exhausts from refrigerating and laundry machinery to supply the distilled water for ice, steam for drying room, etc. In summer the lighting is halved, and the refrigeration and ice are increased one half, the laundry decreasing slightly. The increased amount of exhaust steam caused by the larger refrigeration requirement about supplies the increase in distilled water for ice-making, and a large part of the steam released by the decrease in lighting is used for heating the feed-water for the boiler. If the refrigerating factor were absent (ice being bought outside), nearly all this exhaust steam would be wasted. If the lighting factor were absent (electric light or gas bought from a company), the steam for heating would have to be obtained from the boiler direct, sacrificing the value of its expansive power. If the heating factor were absent, more than sixty per cent. of the heat energy would be wasted in winter.

But not only is steam economised by this combination; the consequent lightening of labor and capital charges is an item of still greater importance. One set of engineers, firemen, and assistants will attend a complete plant as well as one that lacks a third of completion. Electricians, ice handlers, etc., will be needed for their especial branches, but the number required for the production of the energy only will not be greater. Nor will the capital required for the production of energy be increased, as it has been found almost invariably that a plant capable of supplying all the electric light required will be capable of supplying all the other requirements as well. This fact is due to the way in which the different functions 'sandwich" in with each other, avoiding concurrence of their separate maximum points.

In buildings used for manufacturing the conditions differ, but similar results may be obtained. In these light is used for a couple of hours only, and principally during the winter. Power, however, is used for elevators, presses, and sewing machines; localised high temperature for irons, glue pots, candy formers, and such apparatus; and low temperature for dye vats, feather steamers, steam ironers, etc. Using the steam first for power to run an engine dynamo to operate elevators, presses, etc., and to furnish high potential heat and light, the load may be fairly equalized, and the exhaust steam will serve, as in a hotel, for heating the building, for dye vats, ironers, etc., and for the feed-water of the boilers. Frequently a storage battery will prove a profitable investment for night work and for equalizing the load. The author has had occasion to instal such a system in a ten-story building where previously electricity was bought by the tenants for lighting, elevator, and pump and motor service, and where gas was bought for lighting and localized high-temperature heating. A large boiler, too, was run in the basement at low pressure for heating, and a small boiler on the tenth floor for dyeing and steaming. Under the new system all these are supplied from the single source, with no increase in labor charges beyond the addition of a fireman. The question naturally arises: why stop at supplying a single house? Why not carry the principle to a number; in fact, where is the limit? The limit will be reached when the exhaust steam can no longer be supplied for heating, when the cost of street-crossing, insurance, or taxes, overbalances the benefit to be derived, and when the increased cost of labor is proportionately greater than the increased business. A plant of a certain size may be run by a unit-body of men, and any increase beyond this amount requires nearly the doubling of the force and a large increase in the capital employed. Each case has its peculiar points, which require careful investigation, and any general rule would probably fail at the first application. The unit in New York is generally, on account of insurance laws and for speculative reasons, a single building, but in many instances the unit could profitably include a square 1,000 feet on the side, and, with increase of concentrated tall buildings having similar needs, it could doubtless be extended further. The central stations for the supply of light or steam or ice separately met all the requirements when the buildings were low and spread over a large area, but the new conditions must, in the author's opinion, bring about a system of block stations and isolated plants with which the central station for a single item will be unable to compete.

REVIEW OF THE ENGINEERING PRESS

The Biggest Mine of All.*

He was a mining engineer,
Thoroughly trained in every sphere
    Of knowledge scientific;
The catalogue of things he knew,
In theory and practice too,
Would cast a spell on me or you,
    As something quite terrific.

Chemical unions he could loose,
And most refractory ores reduce
    To reguline condition;
And, having conquered many lands,
He sought fresh triumphs for his hands,
When, walking on the ocean sands,
    He felt a new ambition.

Before him in the sunshine rolled
The largest known supply of gold,
    Though somewhat low-grade was it!
The stuff was soft and easily won,
And carried (said Professor Don)
About nought point three cents per ton—
    A wonderful deposit!

And it was uniform, no doubt;
If it were mined, year in, year out,
    With proper assiduity,
It would go on and pay to man,
As no mere land-deposit can,
The dividends it first began,
    In endless continuity.

Besides, of such productive work
No "apex-right" or legal quirk
    Could thwart the rich requital;
For everybody knows the sea
To everybody's use is free,
With neither rent nor royalty,
    By immemorial title!

The sailor cleaves it with his keel
For cod or mackerel, whale or seal;
    It yields the bather's toilet:—
Why should not the metallurgist,
On small or large scale, if he list,
A part that never would be missed
    Abstract, and simply boil it?

"The scheme's complete!" he proudly cries
"It only needs that I devise,
    "My skill profound displaying,
"Some process, either cold or hot,
"Thorough and practical, and not
"Too costly, which will give me what
    "The wild waves are assaying!"

He built a wondrous structure then,
Which thoughtless, undiscerning men
    Despised as hocus-pocus.
It held a monstrous burning-glass
Through which the solar rays would pass
To pierce the seething, sizzling mass
    Of ocean at the focus.

And then there was a coffer-dam,
Which, inexperienced as I am,
    I dare but slightly mention,
And wires electric—what their need
Or use, I cannot say indeed;
But they belong, it is agreed,
    To every new invention.

When all was done, he calmly sat,
As some contented, stately cat
    Sits gravely looking at us,
And waited for the fateful day
When he should reap the golden pay
Resulting from the opera-
    tion of his apparatus.

The process turned out cheap but slow;
He saw the seasons come and go
    With patient desperation,
While bravely he would still repeat
To all the explanation neat,
That his solution was complete,
    But lacked precipitation.

His eyes grew dim, his hair grew white,
His creditors forgot him quite;
    The speculative fever

* Dr. Raymond's lines, which are given herewith in full, were read at the Atlantic City meeting of the American Institute of Mining Engineers and were suggested by the experiments of Dr. Don, of New Zealand, communicated to the Institute in a recent paper, and the other stories of the extraction of gold from sea water then, and since, current in the daily papers and the technical press. THE ENGINEERING MAGAZINE does not often emulate the example of Mr. Wegg, but in this instance is delighted to show its appreciation of the novel style of the honored Secretary's communication by presenting it in its completeness, rather than any comment which would lose the flavor of the original.—EDITOR.

Had ceased, except in him, to burn—
They did not even care to turn,
And get the leaky old concern
Attached to a receiver.

At last there came a stormy day
When a great wind laid bare the bay—
A most uncommon antic—
And what was more, the hurricane
Banked up the dunes along the main,
So that no drop came back again
Out of the vast Atlantic.

The aged mining engineer
At this catastrophe, I hear,
Was staggered for a minute.
But science was not long at fault;
After a transitory halt,
He mined that coffer-dam for *salt*,
And found a fortune in it!

R. W. RAYMOND.

American Export Manufactures.

THE remarkable change in trade movements, especially as between Great Britain and the United States, forms the subject of an instructive editorial in *Bradstreet's*.

From the figures presented, it appears that, while Britain's exports to countries other than the United States have remained practically constant for the last three years at about £215,000,000, the exports to the United States have rapidly declined in the same period from £25,697,000 in the fiscal year ending June 30, 1896, to £14,687,000 in the year ending June 30, 1898.

On the other side of the account, British imports of American products have increased during the same period from £91,332,000 to £123,399,000, while the imports from other countries have scarcely varied from £338,000,000 per annum.

Commenting upon this, the writer says:

"It is seen that practically the entire gain in British imports during the past two years has been in products of the United States, and the natural effect of this one-sided trade is shown in the fact that, while we bought to the extent of £14,687,000, we sold goods to the British of the value of £123,399,000, leaving a balance in our favor of £108,712,000, or $527,253,000, a sum which, it is safe to say, has never been equaled in our dealings with this or any other country or by any other year in our history.

"Naturally, such an enormous trade balance against them has been viewed with some concern by our British cousins, who have been anxiously looking for signs of a change in this very one-sided feature of international trade or barter. They comfort themselves, however, with the notion that the above showing is now history not likely to be soon repeated. With the return of peace they look for better trade in this country, together with enlarged buying abroad and consequent heavier sales of British goods to us. At the same time, with better crops in England and elsewhere, they look for necessarily smaller payments to America, and, in fact, a return to the normal in trade relations with this country. That British expenditures for American produce the present year are likely to be smaller than those of last will be conceded by many, but whether there will be a return of the heavy American buying, which was a feature of former years, will not be as readily admitted, and there are even some British observers who seem convinced that the development of American manufacturing industry will prove such as to permanently emancipate America from the necessity of ever again buying to the volume reached in former years."

There is no question that American industrial manufactures are not only able, but forced, to seek markets beyond the national boundaries, and that machinery and machine tools, especially, will henceforth appear as a considerable and rapidly-increasing item in the export trade of the country. But, in buying them, England is simply equipping herself with the means of cheap production which have given the American manufacturer his ability to compete with the older countries, and thereby placing herself in the best position to meet his competition, if such it be.

It should be observed, however, that with the rest of the world England has steadily maintained her full volume of sales. Every one familiar with industrial conditions there knows that her work-

shops are full to overflowing with work and orders, many of them for months—and even years—ahead. Many of her purchases of foreign machinery and supplies, indeed, have been dictated by the absolute inability of her own workshops to supply in time her own wants. The rapid opening of new countries, the development of their natural resources, the general rise in the standard of living everywhere—all these promise to tax by their demands the productive capacity of all the great industrial nations. To come nearer home, the neglected field of electric traction in Britain, so ably discussed by Mr. Knox in this number of THE ENGINEERING MAGAZINE, offers vast opportunities for the engineering trades.

Beyond all this is the yet undeveloped reserve productive capacity of the British workman, heretofore held in check by short-sighted labor-union regulations. The indications are strong that trade unionism in England must yield its foolishly-conceived position and make way for the methods of intensified production which characterize America and the continent; but there is small cause for England to be alarmed at her imports from the United States—especially her imports of the tools and, with them, the methods which are the means of cheap and rapid production.

Tall Buildings in Rome.

THE tall building is looked upon as so exclusively American that it is startling to be told that even in this the nineteenth century is not original. It is not, however, in this instance, the Chinese whose footsteps marked the earlier path, but the Romans. Prof. Lanciani, according to *Architecture and Building*, has discovered that there were building laws in Rome two hundred years before the Christian era. The steps seem to have been exactly similar to those recently witnessed: crowding of the population into the cities; enormous increase in price of urban property; successive additions to the number of stories, in the effort to secure proportionate rentals; and, finally, interposition of the law-makers in the interest of public safety. Gloomy forebodings as to dangers from fire, speculations as to the menace from deterioration or decay of the structures themselves, and complaints of the darkened streets were familiar then as now. Nor is it surprising to learn that many of the plagues and pestilences are attributable to the dampness of the overshadowed streets and the exclusion of the sunlight.

"There are frequent allusions among the Roman historians, orators, and poets," says *Architecture and Building*, "to the enormous height of the tenement buildings of Rome, but no definite figures are given until the days of Augustus, when a law was promulgated by the senate which fixed the height of new structures at 60 feet on the street front, without making any allusion to the height of the rear. It is, however, known that in the rear these tenement buildings rose often several stories higher than in the front, so that from a distant height, as from the top of a temple which commanded an extensive view, a row of tenement buildings in Rome presented the appearance of a terrace—highest in the rear and descending by stories toward the front. The law of Augustus applied to new buildings, respect, then as now, being shown for investments already made. The number of stories on the street front of these Roman buildings was generally ten to twelve, with fourteen or fifteen in the rear. The lowest stories were 8 or 10 feet in height, but, from accounts given by the writers of that time, the stories appear to have gradually diminished as their height above the ground increased, so that the topmost tenants lived in quarters where very often they could not stand erect. That the stories were sometimes much less than 5 feet is shown by the discoveries in Pompeii, where, in a house inhabited, presumably, by poor tenants, a story of 4 feet 3 inches has been discovered. This was a living room, too, for in it were found all the articles which pertained to Roman housekeeping—cooking utensils, beds, stools, mirrors, combs, brushes, and other things which, with the bones of the family, furnished indisputable evidence that the rooms had been occupied. It is

quite likely that there were thousands of rooms in the tenement districts of Rome that were no higher than this Pompeiian tenement, and, indeed, more than one Roman poet alludes to the lodgings into which he must 'creep,' the word, perhaps, indicating, not a figurative, but a literal, method of entrance. That the tenement houses of Rome towered at least 100 feet above the street in front, and probably 125 to 130 feet in the rear, is certain, for the promulgation of an edict limiting the height to 60 feet in front indicates that this height had been so greatly exceeded in so many cases that the public safety was believed to be imperilled. How many stories were contained in these tenements is conjectural, but, if the upper stories were no higher than that of the house in Pompeii, the Roman tenements may have contained as many or more stories than the modern office-building."

Perhaps it is only a completion of the parallel to be told that the building laws were continually ignored or evaded, and only Nero's celebrated and certainly sweeping methods secured, for a time, the abolition of the tall building in Rome.

Prof. Haupt on the Nicaragua Canal.

COURTESY to Prof. Haupt, and the desire, in the interest of fair dealing, to afford him the opportunity to defend his position, lead us to give space in these columns to his comment upon Mr. Nimmo's strong arraignment of the Nicaragua canal project, published in THE ENGINEERING MAGAZINE for August, 1898.

With due deference to Prof. Haupt and the other earnest advocates of the canal, the attitude of the magazine, as evidenced by its former publications on the subject, is one of dissatisfaction with the evidence so far offered as to the engineering feasibility of the scheme advanced, skepticism as to the commercial advantages of the canal, and strong opposition to the governmental espousal of the undertaking.

Prof. Haupt's rejoinder is as follows:

"On my return from a trip to the south my attention was directed to the supplementary article in THE ENGINEERING MAGAZINE on the Nicaragua canal by Mr. Nimmo, former statistician to the government, purporting to show why this great highway of commerce should not be built and introducing into his presentation personalities and opinions which seemed to be out of place in a magazine article. While I do not propose to enter into a controversy on this question and shall not lay stress upon his misquotations, I desire to state that, in reaching his conclusions, the writer has reiterated many erroneous premises which have been frequently refuted in the daily press, and has ignored the fundamental axioms of transportation, of which, however, he does not profess to be a master. The fact that he should have so unjustly misconstrued my computation of the increment in value of commerce, when the details of the calculation were so fully set forth, showing that I limited myself to a simple, and not to a compound, ratio, to keep within safe limits, indicated a bias intended to discredit a logical conclusion as to the great value of the economics resulting from this would-be canal. This class of argument merely tends to weaken the special plea alleged to be made in the interest of the transcontinental railroads. As a matter of fact, confirmed by experience, it is my belief that our transcontinental lines will be greatly benefited by the colonization of the Pacific coast which would result from the opening of this waterway.

"It is a striking illustration of the scope of the writer's perspective that he should limit the amount of the traffic to only 300,000 tons per annum, whereas a well-informed ex-governor of one of our western States predicts a traffic of 2,500,000 tons from coal alone, which would be new business for the canal. But it is not my purpose to discuss the commercial question; time alone will answer the doubts and predictions of both the advocates and opponents of the canal, for this great work, like all others tending to promote the general welfare of mankind, has its experiences, and a war of words will determine nothing. Current events seem to point conclusively to the consummation of the desires of centuries to unravel the secret of the Straits, and I believe our

country is thoroughly alive to its solemn duties and obligations in the premises and will not hesitate to assume its responsibilities. May the crowning act of the century be the inauguration of the Nicaragua canal!"

The Opening of the Indies.

THE prognosis of a sudden expansion of manufacturing and engineering enterprise in countries heretofore stagnant or retrograding under Spanish rule, and the similar opportunities afforded by the new conditions in China, have been so often proclaimed and are so generally recognized that a mention of them is trite.

To the American, however, who has but recently begun to seek the broader markets of the world, the situation presents a more novel interest than to his European competitor who has long been familiar with corresponding ventures. The requirement is not an adaptation to incidental conditions, but to a new policy, for, while American influence will naturally be paramount in Cuba, Porto Rico, and the Philippines, it will be by no means exclusive. The Englishman and the German, long accustomed to seek an outlet in foreign countries, will be wide awake to the fresh opportunities and early and active on the ground.

The *American Machinist* aptly says: "It is not to be doubted that we shall receive the lion's share of Cuban trade. Even under Spanish rule we obtained a considerable portion of it, despite the discriminating duties in favor of the home government, which showed how superior would be the advantages of trade with us under equal conditions."

The point to be emphasized is that the conditions are much more equal, broadly speaking, than those to which the manufacturer in the United States has been accustomed in his home trade. The artificial elements will be largely eliminated, and the footing made approximately equal for all contestants. Even in internal relations, there is a strong tendency toward the belief that America is reaching the final stage implied in Garfield's maxim of "protection with a view to ultimate free trade," and, as to these newer fields, there is, as the *Machinist* says, "a disposition on the part of our Government to introduce the policy of the 'open door' in its dependencies or quasi-dependencies. Even such a strong tariff man as Mr. McKinley apparently recognizes the fact that the doctrine of protection of industries is inapplicable where such industries do not exist, and, if a liberal policy in this respect is satisfactory to the protectionists, *a fortiori*, it must be so to the free traders. Let us then rid ourselves of the idea that the West Indian islands are going to be an exclusive game preserve for us, and let us rather practise to increase our accuracy in bringing down birds of business in rivalry with the Germans and others who are good marksmen."

An instance of German methods in this style of hunting was recently afforded by one of the leading directors of engineering enterprise in that country, who stated that his house had sent to China two intelligent young men to study the language and two engineers to examine the opportunities for industrial work. At the end of a sufficient period, one linguist and one engineer would return to the home office, the others remaining in the field, thus establishing complete touch between the two ends of the organization.

The American, once he seriously undertakes the problem, will prove as skilful in adaptiveness as he has been in mechanical ingenuity, but he will need to possess himself of all that is best in the methods of all his rivals—and improve upon it wherever he can.

More Rail Joints.

AT the annual meeting of the American Society of Civil Engineers in January last Col. H. G. Prout introduced a resolution as follows: "That it is the sense of this meeting that a special committee be appointed to consider the subject of Rail Joints for Standard Steam Railroads, and to report to the Society certain joints for discussion, and that this subject be referred to the Board of Direction for its action."

So far, so good; but from the *Railroad Gazette* of August 19 we learn that,

although the annual convention of the Society adopted this resolution to the extent of instructing that it be submitted to the Society at large in the form of a letter-ballot, it is to be feared from the tendency of the discussion that the resolution may reach the Society in an emasculated form—emasculated in that its scope may be confined to an investigation of angle-bar standards only.

If it were not that the Society is always so conservative in its action, it might be suspected that the intention of some members who took part in a discussion of the resolution was to draw its teeth; for any investigation of rail joints conducted by such men as are absolutely essential to the framing of a valuable report should not be restricted to the examination of angle-bars only. If it is so restricted, its value will not be in the least doubtful; it will be worthless. Furthermore, it is possible that engineers of wide knowledge and reputation will hesitate to take part in so fruitless a proceeding, and, without them to answer for it, the weight and force of the report will be gone.

This conservatism of the American Society, so admirable in its way as a rule for guidance, leads the society by its excess into strange methods, and, for fear that their transactions may be polluted with the name of a patented article, or because one of their committees may be brought into contact with proprietary devices during the course of an investigation, they find themselves estopped from acquiring many desirable and useful facts. Nevertheless the back pages of the "*Transactions*" are devoted to advertising.

Neither the writer nor (probably) any member of the Society wishes it to recommend any special or exclusively-owned form of rail joint, but there may be, and very likely is, a patented joint which best embodies the principles of a thoroughly successful one. If so, the committee should test it in every possible way and include their deductions in their final report; to follow any other course would be to disappoint the members of their profession. For the duties of this body,—the American Society of Civil Engineers,—are not confined to the roll of its own members, but extend to many thousands of outsiders, ineligible from the force of circumstances, but vitally interested in the subjects of the Society's deliberations.

What is the best form of rail joint to meet the conditions obtaining on our railroads? That is the question. Angle-bars play but a small part, and, in the opinion of many engineers who are well qualified as judges, a lessening part, in the matter as a whole.

The very use of the term in the discussion is enough to prejudge the decision in some minds. The angle-bar is only one of many means for joining the ends of two adjacent rails, and to investigate angle-bars only as angle-bars, and not as members of a large class, would be to start at the close, instead of at the beginning, of the subject.

But, if the work of the proposed committee is to be thoroughly done, it has a long and hard road to travel before it can decide on what is the best form of rail joint. What is the best part of the rail to which to apply the pieces composing the joint? What shall be the general arrangement of these pieces? What are the forces of impact which must be met? Shall the joint be supported on one, two, or three cross-ties? What is the proper distance apart for these ties for different weights of rail? How do the quality and depth of the ballast affect the behavior of the joint?

And then, after all this is known (it is not *known* now—some of it is guessed by a few shrewd men, but it is only guessing at best)—after all this is known and the best joint is decided upon, the committee will be met with the question whether joints should be used in the main track at all, except in rare instances—as, for example, at frogs and switches. Has not the time come already for continuous rails, riveted, welded, or cast together?

Here is a considerable field for investigation, and, without a carefully-weighed decision on each of these and many other points, reached only after the most intelligent experiments, the final report may well do more harm than good.

The work of the committee on standard rail sections, difficult though it may have been, was child's play beside it, and one may well shrink from the responsibilities and labor connected with the search. Nor can the work be done without a considerable expenditure of money. Many pieces of track embracing various sorts of traffic must be maintained in different parts of the country. They must be closely watched, compared, and recorded, and this cannot be successfully done except by men who are under the authority of the committee.

In the track experiments the committee will undoubtedly have the financial and moral coöperation of many railroads, and it will also command the experience of any one whom it may choose to call upon; but still its labors will be immense, and it must be years before it can make a report.

Col. Prout has started a very innocent-looking ball rolling, but, before it is safely lodged in the archives of the Society, it may develop into a first-class planet. He has, however, suggested the only way by which this complicated question can ever be intelligently formulated and discussed. It remains with the Society to see that it is properly entered upon and carried through.

Garbage Disposal.

THERE seems to be, as yet, no consensus of opinion, at least in American cities, upon the solution of the problem of the most sanitary and most economical method of garbage disposal. One great difficulty probably lies in the widely-varying conditions to be met in different localities. The differences are partly natural, as for instance the very important elements of city plan and topography, affecting the cost of collecting, which is a large item; the distance to which, and means by which, the collected garbage is transported to the disposal works; the existence or non-existence of a local market for the possible products of recovery, which are of low grade and will not bear the costs of carriage to any considerable distance; and the uling prices of fuel and labor. Again, some very important considerations are in a sense artificial, arising from the wide differences in local usage or regulation (for it is commonly a matter of municipal legislation) as to what constitutes the garbage of the city.

The tendency, however, is very strongly toward the withholding from the garbage, in more concentrated form, of the formerly considerable by-products which gave it commercial value. These are grease, and animal waste carrying nitrogenous and phosphatic compounds which are useful as fertilizers. The close study of economies in the establishments which were formerly the greatest waste-producers has brought about a change in methods by which the marketable materials are recovered before any fermentative or putrefactive process has set in. Indeed, it is facetiously said that nothing now escapes unused from the great "packing houses" of the west except the squeal of the hog and the curl of his tail. Naturally concurrent with this movement has been a great decline in the selling-price of such by-products.

It may be taken for granted, therefore, that the "reduction" or destruction of city garbage is not, *per se*, a commercially-profitable undertaking. The point is worth making, because many schemes have been urged upon investors under very different representations. It is on a par with street-cleaning—the profit to the contractors is the margin between the sum recovered from the city and the cost of the disposal. And the recoverable products are so small, in proportion and in value, that only in special instances will they justify any "process" for saving them. In the great majority of cases, to attempt it is to imitate the man who burned a sixpenny candle looking for a lost pin.

The future will probably see the general adoption of a simple, well-designed furnace for destroying the garbage by burning. An admixture of a portion of the city ashes might help mechanically, and very possibly furnish enough unburned coal to carry on an active combustion without any other fuel.

The naphtha-extraction processes which

were so energetically exploited some years since seem to have dropped into a merited oblivion, and the day of steaming-and-pressing methods is here.

The Engineering Record furnishes descriptions of two large installations on the system, the first of which, on Barren Island, is especially interesting because it is the largest undertaking of the kind in the United States. During the summer of 1897 the maximum amount received per day was about 800 tons, but considerably less is reported as being received during the corresponding months of the present year. The striking difference has not been satisfactorily accounted for.

"In the original plant there are two lines of digesters, each containing 24 units; each digester is 6 feet in diameter and 15 feet high, with charging holes in the center of the top and discharging holes in the center of the bottom, with steam-pipe connection for live steam for cooking the garbage and for exhaust steam led away to the condenser. The garbage is cooked from 8 to 10 hours at a temperature of about 310 degrees F. under 60 to 65-pounds' pressure per square inch, after which it is discharged by gravity into the receiving tanks, of which there are 12, each 7 feet high, 14¼ feet in length and 12½ feet wide, each receiving the cooked garbage, called tankage, from four digesters. Each receiving tank discharges its tankage, when required, into a press immediately under it, having a 4 × 5 platen, operating with a pressure of about 100 pounds per square inch. The charge for a press-full is disposed between crates in thin layers, 16 in number, each confined at the edges by canvas bagging. The liquid effluent from the presses is run through a series of 10 grease tanks, which permit the cooling and the skimming of the grease, from the last of which the liquor is pumped to the evaporators, where it is reduced to the consistency of thick syrup and is called 'stick;' this is now added to the dried fertilizer to enrich it, though formerly, and until required by the board of health to do so, the liquor, after leaving the grease tanks was discharged into the waters of the Jamaica inlet on which the plant is situated. The solid residue remaining in the presses and called 'sludge' is taken in cars to the rotary dryers, large horizontal cylinders with horizontal axes, heated by live steam jackets, and the contents stirred continually, while drying, by a rotating shaft running through the center, carrying arms or paddles. The steam and vapors driven off in this drying process are led away to condensers by a slight suction produced by the condenser itself. Similar suction is applied to the exhaust steam from the digesters, and to the evaporators used in reducing the press liquor to 'stick.'"

The other plant described in the *Record* is at Detroit, and handles from 70 to 90 tons a day. The process is essentially similar to that just described—*i. e.*, the garbage is first cooked for seven hours with live steam and finally dried in steam-jacketed dryers, the resultant product being "about 15 per cent. of the original bulk, in a dry, homogeneous, brown powder." The peculiar feature of the process, however, is the intermediate step between the cooking and the drying. Instead of being put through presses at this stage, the garbage remains in the original tank, and "steam at a pressure of 80 pounds per square inch is forced into the tank from above and also from below. The liquid from the garbage is then forced out by means of the steam through a pipe under the perforated bottom. The steam pressure is continued on the tank for a period of four or five hours, during which time nearly all the liquid and grease are squeezed out of the material, leaving about 30 per cent. of the original garbage in weight in the tank."

This should certainly have a diagram.

The garbage contract has been so fruitful a source of political jobbery that great value attaches to any clear description of apparatus and methods which will dissipate the mystery so frequently thrown around the subject. If figures of amounts treated, yields, values, and working costs could be widely-spread, the reign of the jobber, in this field, would be at an end.

THE BRITISH PRESS

American Progress in English Industries.

THE manner in which articles of American manufacture are progressing in English markets is not fully appreciated by every one. A recent editorial in *The Engineer* calls attention to the rapid and continual growth in imports from the United States, especially of engineering products.

"A great deal has been heard of late about the progress of Germany as a rival to industrial England. So much has this been the case that the bitter cry of American competition seems to have been overlooked. All the same, it would not be far from the truth to say that British industry is pressed harder by the Americans than by the Germans."

Much of this is due to the superior efficiency of the American machines and the way in which they are worked by American workmen.

"In England the express purpose is to let the machine do as little as possible. There could have been no more striking example of this than during the late engineers' strike, the crux of which may be said to have been a resolute attempt to slow-time the machinery. In the United States the free use of automatic machinery is the chief factor in the different industries, the workman being anxious to beat the record in the utmost amount which can be got out of his machine. One man may be found looking after half a dozen machines, and even boys are often seen working in the same capacity."

Apart from questions of cost, and the influence which economical production has on selling price, the superior quality of the product often causes British manufacturers to use American products, when their preference otherwise would be for articles of home manufacture.

Examples of this sort of thing are found in malleable-iron castings, which are of such a quality that the workmen themselves are openly heard to confess their preference for the American product, while at the same time the price is 30 per cent. lower than Sheffield prices.

American steel is now being sent into Birmingham in very large quantities, where it is mainly used for bicycle work. For bicycle purposes, for nuts, screws, and bolts, or for anything that can be made in large quantities by means of automatic machinery, the American steel is preferred, not merely by the manufacturer, who finds it lower in price, but generally by the workman, as its uniform temper enables him to work it smoothly with considerably less wear on the tools.

Not only the products, but the American machines themselves, are rapidly being introduced into England, and it is impossible for anyone who is in the habit of visiting the large industrial establishments of England to avoid seeing how rapidly American labour-saving machines are being utilized. Specific instances of this are constantly to be seen,—instances where British manufacturers, who have been fighting all their lives against using American machines, have latterly, through failure to get what they wanted in England, been compelled to adopt foreign-made lathes and other special machines, and now say they would not be without them.

"The business of supplying these American inventions is only just beginning. It is not to the interest of British manufacturers to admit this much, but they are gradually being forced to the conclusion that there is no denying the advance of the American, both in his methods of production, his application of those methods in the use of the machinery by which they are applied, and the men by whom they are worked."

Fighting Floods in India.

THE disastrous consequences which have followed some of the great floods in various parts of India lend interest to a valuable leading article in the *Indian and Eastern Engineer* upon the best methods

of fighting floods; although the conditions are in many ways different from those which obtain elsewhere, in the main the remarks apply well to the general subject of the control of rivers in times of excess of water. Rivers may be divided into four great classes: (1) the tidal; (2) the deltaic; (3) the semi-deltaic; and (4) the torrential.

The first class includes great rivers, such as the Indus and the Hooghly, which can hardly be considered rivers at all, but, rather, high sand banks through which the water wanders at will, and over which a bore of unusual size, or a cyclonic wave, spreads unchecked, carrying death, desolation, and ruin in its train. These floods there appears to be no method of preventing, excepting by means of a systematic series of levees, of enormous cost and problematical benefit.

Deltaic rivers are more defined in their courses than are those mainly under the influence of the tides. When the waters are high, the banks are raised by the deposits of silt, and, as the currents slacken, the deposit forms upon the bed. This raising goes on, until, in some unusually high flood, the water finds an easier flow in some old bed, when the course of the whole river may become changed in a few hours for a considerable distance. Attempts have been made to control such streams by the construction of protecting embankments, but, as usually constructed, these are exceedingly dangerous in the long run. The river-bed is continually raised by the deposit of silt, and the embankments require a corresponding increase; and this goes on, until some unusually high flood carries all away, with much more damage than would have been done had the resistance been less. As soon as the flood is over, the embankments are rebuilt, and, the next time they give way, the flood is higher than ever; and so it goes on. It is far better to attempt to lead nature, instead of fighting it, and, instead of confining the channel to a limited bed, which it is sure sooner or later to break down, to permit moderate floods to spread silt and mud over large areas to the advantage of cultivation.

Records of rainfall are of little use in estimating the proper amount of waterway to be provided, as the irregularity of the fall is too great to permit any reliable conclusions to be drawn. At Karachi, for example, nearly twice as much rain fell on one day in 1896 as fell in the whole of 1895, the total fall for 1896 being three times that of 1895. Provision must be made, therefore, for the quantity which may fall in a short time, if safety is to be secured.

The floods, as a rule, do not affect the large bridges, as their foundations are now placed deep enough to resist any scour which can occur. In the case of culverts, however, the wing walls are too short, and they are frequently undermined. This can be avoided, if the wing walls are continued down to the level of the bottom of the stream, with the invert taken as far as their ends, and the drop walls just beyond, in front of them,—a construction which adds much to the cost, but which pays in the end.

Semi-deltaic rivers have fairly stable beds, and the floods are generally confined to them, the overflow seldom being very deep. The difficulty is not with the banks and waterways so much as with the bridges. The channels are generally very wide; either the stream must be contracted, thus inducing corresponding resistance, or else very long bridges must be built. Formerly such bridges were made with shallow foundations and short spans, but these are now rather out of date, being supplanted by long-span bridges with deep piers. It is a question, however, whether the earlier form is not more economical in the long run, if proper precautions are taken to distribute the flow of the stream over the entire width, and prevent abnormal scour at any particular point.

The long-span bridges, with very deep piers, are expensive in the first place, and, in the second, their maintenance is costly, especially when the width of the river is restricted. Not only the piers, but also the abutments, must be very deep and massive, the wing walls having to be carried very far each way in order to prevent

the destruction of the banks. The cost of maintenance thus may exceed greatly the amount which would have been required for a longer bridge had the river been permitted to occupy the full width of the valley.

The fourth class, torrential rivers, is a difficult one to deal with, but the method is by no means intricate. Good foundations can always be found at sufficient depth, and the spans must be long enough and the piers high enough to provide for the maximum flood. It is a question of cost and magnitude, but, as the banks are usually well defined and of hard material, they are usually safe, without the reinforcement of protecting walls.

The shallow, widespread overflow-floods which occur in some parts of India can hardly be controlled at all, but serious interruption to travel can be avoided by the construction of low causeways and viaducts, sufficient waterway being provided to keep the causeways from becoming dams and diverting the water to an injurious extent. It was formerly the custom, when a bank had to be carried across a narrow and high ravine, to put an expensive bridge or culvert through the lowest part to provide for the water, but the length and size of such culverts have led to the adoption of other methods. By constructing the lower part of the bank of large stones, sufficient opening is left for the water to pass through, while catch-water drains in the solid earth, carried under the road at each end of the bank, intercept a large portion of the water, and furnish relief to the main portion of the bank.

In all such work local conditions modify the general plans outlined above, and in its construction the lessons of previous experience must be heeded.

The Modern Commercial Gas Engine.

AN interesting paper, read before the North British Association of Gas Managers, by Mr. W. Carmichael Peebles, and published in the *Journal of Gas Lighting*, reviews the development of the gas engine, and the lines along which commercial advance is likely to be made, and contains a number of points of value in connection with improvements in internal-combustion motors.

After reviewing the pioneer work done in France by Beau-de-Rochas, and in Germany by Otto and Langen, Mr. Peebles proceeds to note the advent of the Otto silent gas engine at the Paris Exposition of 1878, and the stationary condition of gas-engine construction during the life of the Otto patents. At the expiry of these patents nearly all manufacturers gave up making their own special types of engines, and adopted the Otto cycle, recognizing in it the only really practical cycle for a simple and efficient gas engine.

The great changes which have taken place in the engine since it was first brought out by Otto are: (1) the method of igniting the charge; (2) the adoption of lift instead of slide valves; (3) the increase of compression.

Though these appear to be simple matters, they have been difficult of accomplishment; yet they have been well worth all they cost. The old method of ignition by means of an open flame, as used in the original Otto and Langen engine, required modification as soon as compression was adopted, as the outflow of compressed gas and air prevented the ignition of the charge within. The flame, therefore, was inclosed in a chamber in the slide. While this served after a fashion, the failures of ignition, especially at high speeds, and the difficulty of lubricating, made improvement desirable.

One substitute for flame ignition is the electric spark. Its use includes an electric battery and induction coil, but in some instances these are not objectionable when the advantages are considered. Corrosion of electrodes, and the extra care involved in looking after the battery, etc., however, render this form of ignition not wholly satisfactory; hence the introduction of the hot tube must be considered a step forward in the evolution of the gas engine. Iron tubes, which were used at first, gave some trouble by choking with deposit, and by becoming brittle, and no metal tube gives entire satisfaction, so far as cleanliness, strength, durability, and

igniting effect are concerned. Porcelain tubes, however, which were introduced by Watson in 1881, have proved very satisfactory, especially when, as strongly recommended by Mr. Peebles, a timing valve is used, instead of permitting the ignition to be timed by the compression.

"Compression has been on the increase ever since the adoption of the lift valve. In the early days compression ranged between 25 and 30 pounds per square inch, while now the ranges found are generally between 70 and 90 pounds, depending on the size of the engine."

"This increase of compression has more to do with the economy of the modern gas engine than possibly any other change—firstly, by the reduction in the size of the compression space wherein the burned products may lodge at the end of the exhaust stroke; and, secondly, by the more intimate and closer mixing of the particles of gas and air, thereby insuring a more complete and instantaneous explosion. The highest temperature of the explosion being reached more rapidly, owing to the higher compression, it is not so greatly affected by the cooling action of the cylinder, as the cylinder surface is not much exposed until the piston has moved a little forward; and by that time the bulk of the power contained in the gas has been given to the engine."

A number of improvements have been made in the mechanical details of gas engines, and the modern machine forms a striking contrast in appearance with the earlier engines, with their many cams, springs, gears, and trappy contrivances. Many of these parts have been eliminated in the process of simplification, which generally goes on as the result of practical experience with any complicated machine. The operative portion, however, is still open to much improvement, especially as regards governing and starting, and it is to these features, as well as to increased economy, that the improver of the gas engine should now devote himself.

In concluding, Mr. Peebles says: "There can be no doubt that a great deal has yet to be done to improve the action of the gas engine. The main direction in which a change is to be looked for is, I think, in the cycle. But this would seem almost impossible without introducing complicated mechanism. At present—at least with the smaller sizes—the successful competition of the gas engine with the steam engine is chiefly due to the convenience and economy with which the gas engine can be operated, especially for intermittent work. With engines above 40 or 50 h. p., using producer gas, the cost of working, as compared with steam, is very greatly in favour of the gas engine, as has been proved time after time. We shall find, therefore, that the large gas engines will not stop at 400 or 500 h. p., but increase gradually, year by year, until they compete in power with the largest steam engines made."

Mechanical Features of Naval Personnel.

In discussing the importance of making proper provision for reserves for the royal navy, *Engineering* emphasises some of the salient mechanical features of naval warfare, as brought out in the Spanish-American war; and these are of technical, as well as military, interest.

"On paper there was no great difference between the naval strength of the two powers opposed, but the Americans have practically had a walk-over, because their fleet was better handled and their sailors were more prompt than those of their opponent. This may be said without casting any reflection upon the courage of the Spaniards, for, whatever may be the faults of the nation, we have no reason to suppose that its sailors would not have fought bravely, had weapons been placed in their hands, and had they been trained to the ability to use them."

In England also there is reason to fear that in an emergency many men would be found unfitted for their duties, not so much from neglect and delay of the kind so conspicuous in the case of Spain, as from failure to give sufficient thought to the changed requirements of naval service. The navy has been constantly increased by the addition of ship after ship of the most modern design and equipment, apparently under the impression that they can be manned by sailors not

greatly different in training and ability from those in the merchant marine.

Indeed, it is from the merchant marine that the recruits for the naval service are expected to be largely taken, as they have been in the past; but in the past the ready-made sailors received in the merchant service all the training necessary.

"The advance of engineering science has changed all that. The warship is a highly scientific instrument of destruction, and consequently must be handled by highly-specialised experts. On a modern battleship or cruiser, each man must know his work thoroughly, and the appliances of warfare are so numerous and varied, and so interdependent in their use, that failure on the part of one means disablement of many. For reasons such as these it is impossible to depend on the mercantile marine to supply ready-made sailors for the navy in time of need, even if all ships sailing under one flag were manned by subjects of the queen. Still, any sailor possesses the first essential for a sailor,—namely, sea legs, and, perhaps one might add, a sea stomach. At any rate, he can move about a ship without embarrassment,—a thing that needs many months for its acquirement with ordinary humanity. If on this it is necessary to graft some of the special knowledge needed for carrying out duty on board a man-of-war, it is evident we have a moderately useful hand for subordinate positions. The perfect article is, of course, a sailor who is a man-of-war's man solely,—one who has spent all his time for years in learning the complex details of his profession so thoroughly that he carries on duty without an effort, and is not liable to become forgetful under the stress of great excitement. It may be well to point out, however, that war has often to be waged with far from perfect instruments, and, just as an obsolete battleship would be a tower of strength if the more modern creations on both sides were disabled or destroyed, so may a handful of sailors but half trained in military duties be better than any number of absolutely raw hands."

In view of the evident manner in which the increase in the British navy has exceeded the supply of properly-trained men, *Engineering* makes a strong plea for the increase in naval reserves provided for in the present bill. By offering special inducements to ship-owners to take boys into service for training, and by also enrolling these as members of the naval reserve, much may be done to provide for the demand, so that, should the time of need arrive, it may not be found that ships are plenty, but men lacking.

The Railways of Ceylon.

THE railway system of Ceylon affords an excellent example of some of the problems encountered in colonial work. From a paper on the subject in a recent issue of *The Engineer* we take some interesting features, giving also views of the remarkably picturesque scenery at various points.

"When the government took in hand the building of railways in Ceylon, it was not unnatural that they should have adopted the Indian standard gauge of 5 feet 6 inches, for at that time light railways in India had not taken any extension, and there was always an idea—vague, it is true, at the time—that India and Ceylon would eventually become connected by rail across Adam's Bridge."

Thus, although it is now generally admitted that it was a great mistake to adopt the broad gauge for India, there is good reason for the continuance of that gauge in the main line of railway in Ceylon, especially as the connection across the coral reef known as Adam's Bridge has been authorized, and will undoubtedly be constructed.

At the same time there is much narrow-gauge road in southern India, and in Ceylon the conditions are such as to imperatively demand it in many, if not most, of the districts in the interior. The result is the existence of two parties, one advocating only the wide gauge and the other championing the introduction of the narrow gauge.

"The former party is represented by the government officials, to whom cost is

a matter of small moment, and the latter by the planters and industrial people generally, whose interests are vitally concerned, and whose pockets bear the bulk of the taxation of the colony."

"The narrow-gauge advocates very naturally resent being heavily taxed for railways of a class which they consider very much too expensive, and in determining the routes of which they have practically no voice, at a time when cheap commercial railways in the proper districts would be of the utmost value to them. Now, however, that the government has sanctioned the 5 feet 6 inch gauge on the connecting line between India and Ceylon, the prospects of the Ceylon residents as to realizing their narrow-gauge dream seem further off than ever, unless the planters themselves are prepared to take the matter up and arrange and build their own lines, as has been done to some extent, and to great advantage, by the big planters in the Dutch East Indies."

At the present time there are, in all, 297¼ miles of main line and 32 miles of sidings in Ceylon, all owned by the government, and all of the 5 foot 6 inch gauge, the highest altitude attained by the railway being 6,230 feet above sea-level. Colombo is the head centre of the system, whence a line runs south to Galle and Mataba, and north-east to Kandy, the capital, and to the principal towns on the plateau, which includes the chief planting district. A sketch map accompanying the article above referred to gives the lines of the proposed railways, including both those which have been authorised and those which are projected, the latter being mostly narrow gauge.

The picturesque character of the country, as shown by some of the illustrations, is not without disadvantages, as the overhanging rock at the Meangalla Galleries, between Colombo and Kandy, was the scene of a disastrous landslip in September, 1897. The location, both before and after the accident, is shown in the photographs, and these and others accompanying them give an excellent idea of the engineering difficulties connected with the construction and operation of the lines.

Fallacies Concerning Boilers.

IN nearly every branch of applied science a number of fallacies of long standing have come down from times of imperfect knowledge of the subjects, all of which are extremely difficult to abolish. Probably no one object has been so burdened as the steam boiler, and an editorial in the *Engineer* discusses some of these in an interesting fashion.

One of the fallacies frequently repeated in text-books is that flame will not traverse a tube, and hence that multitubular boilers are wasteful of fuel. This proposition is reinforced by the experiment with a flame and a piece of wire gauze, as in a safety-lamp; because the flame will not readily pass through the gauze, the inference is drawn that it will not pass through the tubes of a boiler. Like many other deceptive statements, this is only partially true; in many cases the flame will not traverse the tubes, and the gas can be ignited at the chimney-top.

"The truth is that whether the flame will or will not pass through a tube depends on the draught. If that is sufficiently strong, the flame can be drawn through a two-inch tube eight or ten feet long, as indeed can be seen at any time by looking through the sight holes provided in the smoke-boxes of certain stationary boilers of the locomotive type. Those who cite the behaviour of the safety-lamp ought to have added that the flame can be very readily made to pass outwards through the gauze by blowing on it; and it is a matter of common knowledge among miners that increased ventilation has been responsible for more than one dreadful explosion, the strong current in the air-way driving the flame through the gauze."

Another prevalent fallacy is that large volumes of carbonic oxide are given off by boilers. The origin of this idea is found in the fact that some of the deep, narrow fireboxes of early locomotives contained so deep a layer of coke that, when the blast ceased upon the stopping of the engine at a station, the furnace became practically a gas-producer, and the carbonic oxide then produced appeared as a stream

of blue flame at the chimney. Now, however, such conditions are very unusual, and, when a boiler furnace is in active operation, there is practically no carbonic oxide present.

"Experiments carried out by Mr. Stead and Professor Kennedy years ago showed that under ordinary conditions very little carbonic oxide is produced in marine boilers; and similar tests only go to show that a fireman must take particular pains to obtain carbonic oxide in any quantity."

"Of all boiler fallacies none is more rampant or persistent than the theory that by preventing smoke we can save quantities of fuel. In dealing with this question, we believe it is necessary to assure our readers that we hold smoke to be a nuisance which ought to be abated, or got rid of completely when possible; and that it is worth while to incur cost and loss to get rid of it. But this has really nothing to do with steam-boiler economy. As a rule to which there are very few exceptions, no saving whatever is effected by making a boiler 'consume its own smoke.' It is quite true that economy often results from the use of self-feeding furnaces, or various appliances, patented or unpatented, with which most of us are quite familiar. The improvement is brought about by quite different agencies. Thus, for example, a mechanical stoker which works well will maintain pressure with more regularity than a man. The proper quantity of air can be admitted, and no more; and so on. It was shown many years ago by C. Wye Williams, who was the apostle of smoke-prevention, that the magnificent rolling billows of black smoke poured forth from the funnel of a Holyhead mail steamer owed their colour to a few ounces of finely-divided carbon; that, in a word, a steamer's smoke-trail closely resembles a comet's tail in the insignificance of the quantity of tangible material which it contains. Sir W. Anderson showed far more recently that, so far from a smoky flame being a worse steam generator than a clear flame, it is far better. But the great practical fact is that boilers which are fitted to consume or prevent their own smoke as a rule are not such powerful steam-producers as those which go through life smoking heavily and creating an atrocious nuisance; and the reason is not far to seek. The proper quantity of air required to burn a pound of coal is twelve pounds. But this would only suffice if it were most carefully mixed with the products of combustion as well as supplied to the solid fuel. In practice nothing of the kind is possible. It is, indeed, hoped that something near it may be secured by the use of powdered coal suspended in an air-current as fuel. But that result has not yet been attained. With an admission of but twelve pounds of air per pound of coal, not only would a great deal of smoke be produced, but carbonic oxide as well. With well-managed fires we may get down to eighteen pounds of air per pound of coal, but twenty-four or even twenty-five pounds is by no means an unusual quantity to admit, if the air is taken in over the fuel."

This is fully in accordance with the results attained by the Paris smoke-prevention commission's report, a review of which is given elsewhere in this issue; and there is no doubt that we must consider the prevention of smoke desirable for reasons of cleanliness, comfort, and health, but not for the attainment of economy in fuel.

Other fallacies in connection with the use of steam boilers are discussed in the article above referred to, and the whole paper is a good example of what might be written about many other departments of engineering practice.

Photographing Projectiles.

In the development of instantaneous photography various attempts have been made to secure distinct images of projectiles in their flight, some attempts having been made with success as early as 1887, by Mach & Salcher, at the Imperial Academy of Science of Vienna.

Their photographs revealed some curious phenomena in connection with the formation of air waves, due to the compression in front of the bullet and vacuum behind it, and later photographic work has added to the stock of data upon this subject.

A general review of the action of various media when pierced by bullets is given in *Engineering*, especial attention being given to the nature of the air waves, and many photographs being reproduced. The study has much interest, whether considered from the point of view of the engineer, the physicist, or the soldier.

The air waves, which in most instances are clearly shown in the photographs, resemble in form those made by a boat, the headwave being of hyperbolic form, with succeeding waves originating at the sides of the projectile, especially where there are ridges or grooves in it, while behind there is a sort of cloudy wake, probably a partial rarefaction.

The head-wave is produced only when the velocity of the projectile exceeds that of sound, since otherwise the waves, which travel at the velocity of the propagation of sound themselves, will always remain in advance of the point of the projectile. This head-wave is the report wave which arrives at the same time as the ball; the man at the target hears no whizzing. If the velocity of the bullet is inferior to that of sound, however, then we hear the buzz, and no head-wave appears on the photograph. These views were entirely confirmed during Mach's first experiments on Krupp's gun-trial grounds, near Meppen. It was noticed that sometimes one report, and sometimes two reports, were heard, the second sound being called the echo of the first. Observers within 150 metres of the gun never heard two reports; for those further away the interval depended upon the velocity and the distance from the gun.

Since no shutter could be made to act quickly enough to make the brief exposures necessary for these photographs, and as correct timing would be impossible, the bullet itself is caused to make the exposure by making an electrical contact between two wires, just as it passes the centre of the photographic field, thus closing the circuit of a Leyden jar and producing a bright spark which furnishes the illumination for the photograph. The bullet is thus produced in silhouette, while the air-waves appear because of the variations in the density of the air which they cause.

Among the photographs are some interesting ones taken at the instant of penetration of a card or of a plate of glass, the reflection of the head-wave being vere clearly shown, as well as the shattering of the glass.

These points are of interest to the physicist rather than to the engineer or the military man; but they possess a further interest at present from the bearing which they have upon the peculiar nature of the wounds inflicted by modern firearms. Ever since the introduction of the Chassepot rifle in the Franco-Prussian war of 1870, charges have been made that various high-power rifles were being used with explosive bullets, such statements having been made in connection with wounds caused by Mauser bullets during the Santiago campaign.

There seems to be little doubt, however, that the effects so closely resembling explosions are in reality due to the waves produced in the medium through which the bullet is passing; and experiments made by firing bullets through bodies of horses, as well as through boxes containing wet sand, clay, and other materials, show that solid bullets can produce all the effects supposed to be caused by explosions. The holes produced by these high-velocity bullets in carcasses were surprisingly large; fisssures formed in the bones diverged both forward and backward, and softer parts, like liver, were projected backwards through several yards.

These explosive effects require a minimum bullet velocity of about 240 metres per second, and are most marked at short ranges, though they may be seen in soft parts up to 2,000 metres.

THE CONTINENTAL PRESS

The Status of the Engineer in Russia.

IN some countries, notably the United States, the title "engineer" gives little or no information as to the professional standing of an individual, unless to it is added some qualifying statement, such as membership in a recognized engineering society, or position upon some extensive works, either public or private; on the continent, however, the mere title indicates either the possession of a technical diploma, the certificate of a government school, or, possibly, the qualification for government service.

In an interesting communication to the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* Herr von Abramson gives the conditions surrounding the status of the engineer and architect in Russia.

In the first place, no one in Russia may use the title "engineer" or "architect" with his name, unless he possesses a government diploma, which latter can be granted only by certain designated technical high schools. This diploma confers also upon the recipient the power to superintend, with full responsibility, construction work anywhere within the limits of the empire, and places him in the tenth rank of the government service, corresponding to that of lieutenant in the army, this being indicated by a special badge worn upon the right breast. Any one not possessing such a diploma, who nevertheless may be a skilled practitioner, or may possess a diploma from some foreign institution, may indicate his profession by the title "techniker," and, in order to have the privilege of assuming sole responsible charge of constructive work in the empire, such an individual must pass an examination before a government board, although this does not permit him to call himself either engineer or architect.

If a practical or technical man, educated in some other country and probably fully qualified by attainments, desires to obtain the title "engineer" or "architect," with all that these imply in Russia, he must enter one of the designated State high-schools, as a native student would. This not only involves the passing of a five years' course of study, but also necessitates the brilliant passing of a severe entrance examination, based especially upon a full proficiency in mathematics and in the Russian language. The term "brilliant" is used advisedly, since the number of applicants far exceeds the available vacancies, and hence only the ablest are accepted.

When the applicant has already received a Russian diploma in some allied branch of applied science, and desires the diploma of engineer or architect, he is permitted to enter the technical high-school without the preliminary examination, and obliged only to pass the annual or semi-annual examinations, the course being abridged to two or three years, according to the rank of the school. This rule also applies to foreigners possessing diplomas from recognized technical institutions of their own countries.

In Russia, in many instances, military engineers are permitted to engage in civil work, mainly in special lines pertaining to government structures and to railway construction, and many army engineers have attained high rank in railway engineering. When a military engineer is engaged in constructive work for structures pertaining directly to the government service, he remains in the active service, and is eligible to promotion in regular order; but, when he enters purely civil work, such as railway engineering, he is passed to the reserve, and is promoted only for cause, based upon exhibition of marked ability. Military engineers engaged in civil work, however, are liable to be called into active service at any time, by order of the minister of war.

Herr Abramson's paper contains much interesting information concerning the

special technical schools authorized to confer engineering and architectural diplomas, showing the nature of the courses and the high character of the instruction. These institutions vary according to the special line of instruction, including civil and mining engineering and architecture, as well as the branches of a general liberal education necessary for an intelligent practice of the profession.

In consequence of this strict regulation of engineering education and control of the privileges of practice in Russia, the professional status of the engineer and architect is clearly defined, and an *esprit du corps* maintained which otherwise would hardly be possible. While there may be some loss to the science of engineering from the absence of foreign engineers, due to the strict requirements for admission to the privilege of practice in the empire, yet, as a whole, the cause of Russian engineering is well served by the native profession, and the progress which has been and is being made shows that ideas from abroad promptly find their way into active use.

Smoke-Prevention in Paris.

IN Paris, as in other cities, the growth of the smoke nuisance has produced numerous calls for legislation looking to its abatement, and, before proceeding to legislation which might prove either ineffective or oppressive, the municipal authorities decided to appoint a technical commission to investigate the entire subject.

This commission has been in active operation since 1894, and, having practically concluded its labor, is making the results public, these being given in abstract in recent issues of *Le Genie Civil*, and as a full report, serially in the *Revue de Mecanique*.

In order to be fully informed as to the best smoke-preventing devices available, the commission decided to institute a series of tests, offering prizes to the furnaces giving the best results; and the report includes descriptions of the various devices submitted, with a critical account of their performance.

One hundred and ten different forms of smoke-preventing apparatus were entered for competition, classified as follows:

1. Mechanical stoking and uniform combustion	16
2. Supplementary injection of hot or cold air	20
3. Injection of steam, with or without addition of air	5
4. Mingling of flames and combustion of smoke	7
5. Gas producers and gas firing	7
6. Pulverizing the fuel previous to combustion	2
7. Washing of the discharge gases	16
8. Miscellaneous systems	37
	110

The various devices were successively erected under the same boiler,—one of the so-called "elephant" type, with two heaters below, this being the style commonly used in France,—and the same fuel was used in all the tests. This fuel was the Anzin briquette, of the ordinary quality, containing an average of 8.17 per cent. of ash, and 17.84 per cent. of volatile matter. Each device was subjected to two kinds of tests, one with slow firing and the other with the firing forced to supply the engines fed by the boiler to their full capacity. Each test was made twice, the first time with a stoker selected by the maker of the device, and the second with the stoker employed by the commission, thus eliminating as much as possible the personal equation or individual elements. The tests included the determination of the quantity of fuel burned per unit of grate area, and the evaporation per unit of area of heating surface and per unit of weight of fuel, as well as the measurement of the relative amount of smoke produced.

The measurement of the amount of smoke produced by each device was accomplished by an ingenious method, which, while probably hardly entitled to be considered as a method of precision, was still reasonably correct, and doubtless fair to all the devices tested.

A smoke scale of five degrees of intens-

ity, ranging from complete absence to complete opacity, was decided upon, and the amount produced was recorded upon a cylinder revolved by clockwork, by means of a pencil which could be pressed into contact with the paper by hand. The observer watching the chimney top pressed the pencil against the paper during any period when smoke was produced, the paper being divided into five portions corresponding to the five grades of smoke. The ordinates thus represented time, and the abscissas represented smoke. The area enclosed was measured by a planimeter, and this area was taken as a measure of the smoke production of the particular furnace under consideration.

Of the many devices submitted to these tests, three general types gave results which appeared to be reasonably satisfactory. Two prizes of 5,000 francs each were awarded to the Donnelly furnace and the Proctor mechanical stoker, while a prize of 2,000 francs was given to the Hawley down-draft furnace. In addition to these, honorable mention was given to the furnaces of MM. Dulac, Hinstin, and Orvis, the awards in all cases being based upon the results of the measurement of the diagrams produced by the smoke-recorder.

The Donnelly is a coking furnace and the Proctor a mechanical stoker, while the remaining furnaces endeavor to insure complete combustion by thorough intermingling of the gases with a suitable amount of air, the Orvis using, in addition to the natural draft of the chimney, the force of a steam jet.

Without going too fully into the details of the tabulated results, for which the reader is referred to the articles above mentioned, the conclusions of the commission may be given, as applying generally to the smoke problem, both in Paris and elsewhere.

In the first place, the experiments made before any of the special devices were tried showed that the ordinary grate is unsuited for smokeless production, and that, even with the most careful stoking, the common grate will permit the formation of smoke.

In the second place, it was clearly demonstrated that smoke-prevention and economy do not necessarily go together. The blackest of smoke represents an insignificant amount of fuel, and the tests demonstrated that the devices which produced the least smoke were not the most economical. It should, therefore, always be assumed that the prevention of smoke involves expense, proper allowance being made therefor.

Smoke may always be prevented by using coke, but, as this is, in many cases, unavailable, the only remedy lies in the use of such devices as will produce a minimum of smoke, the true principle being, not the combustion of the smoke, but the absence of its production.

The commission recommended the prohibition of thick black smoke, as the trials showed that many devices would accomplish this result. It was also recommended that those devices which showed the best results during the tests be placed in manufacturing establishments with a view of establishing their durability and effectiveness in regular service, and, above all, that the existing regulations be thoroughly enforced by patient and competent officials.

The Correction of the Rhine at St. Gall.

AMONG the important river-improvement works recently completed in Europe, the correction and regulation of the upper Rhine, at its entrance into the lake of Constance, is well worthy of notice, and a paper in the *Schweizerische Bauzeitung*, by Herr J. Wey, the chief engineer of the undertaking, gives a condensed account of the nature and extent of the work.

For a long time the irregular action of the river upon the lands of St. Gall and the Vorarlberg has been a source of much trouble, the sinuous nature of the stream and the low banks lending themselves readily to the production of destructive floods in time of high water, so that the surrounding territory was frequently overflowed, much damage being done.

Instead of endeavoring to protect the banks by the construction of embank-

ments upon both sides, following the path of the old channel, it was determined to construct two entirely new sections, forming cut-offs which would straighten the stream, and also enable the surrounding country to be protected both by the embankments and by the relief to the water afforded by the more direct outlet to the lake. The second, or Fussacher, cut-off forms an entirely new mouth of the river at its entrance to the lake of Constance, the old mouth, with its delta, being left more than five miles to the left of the new bed. The first, or Diepoldsauer cut-off, straightens the stream so that the old channel is left nearly a mile and a half to the right, the two new channels shortening the river nearly six miles and a half.

One of the most interesting engineering feats in connection with the work was the construction and operation of the dredge by which the cut-outs were excavated and the embankments constructed. This apparatus consisted of two separate iron hulls. The first was 22 meters long by 7 meters beam and 2.6 meters deep, and carried the bucket dredging apparatus, which was operated by a compound engine, the buckets containing about 110 liters each. These buckets deposited their charge upon a grating of 10 to 12 millimeters' spacing, this being sufficient to retain the coarser gravel and pieces of stone, while the sand, earth, and finer gravel passed through. A powerful centrifugal pump, driven by a direct connected engine making from 600 to 700 revolutions per minute, directed a stream of water upon the mass, washing the finer material through the grating to a reservoir in the second boat, from which the fluid mass was discharged by means of two centrifugal pumps, which delivered through rubber tubing supported upon traveling carriages. The coarser material, which could not pass the grating, was delivered upon rubber-conveying belts, which, supported upon a cantilever framework, delivered the stuff to the banks on either side, to assist in forming the enbankments.

The second boat, which was 16 meters long, 6 meters beam, and 2.6 meters deep, contained the centrifugal pumps, with their motive power, as well as the tower which formed the central portion of the cantilever carrying the conveying belts. The whole formed a very effective apparatus, and proved of even greater capacity than its rating of 75 cubic meters per hour.

In addition to the construction of the new cuttings, the regulation work involved the canalization of that portion of the old channel which was retained, the embankments protecting the banks and enabling the flow to be controlled within reasonable limits, even in times of high water.

The entire work has been completed, after six years of active operations, at a total cost of more than 23,000,000 francs.

The Elasticity and Strength of Materials

MUCH attention is constantly being given in various technical journals to the questions involved in the resistance of materials of construction to deformation, and the study of the nature of the internal stresses induced by external forces is a feature which has developed as our knowledge of the structure of the materials themselves has advanced.

In recent issues of the *Zeitschrift des Vereines deutscher Ingenieure* there have been several important papers bearing upon this subject, and, although the nature of the investigations and the necessary use of mathematical expressions prevent a full review in these columns, some general idea of the treatment can be given.

Among these papers is one by Dr. Kirsch, of Chemnitz, upon the theory of elasticity in relation to the resistance of materials. Taking as the starting-point the fundamental principle that in an elastic body the extension is directly proportional to the load, he considers the material as composed of successive very thin layers, all parts of each layer being equally distant from a neutral axis or surface, and proceeds to show the unequal deformation in various portions of a body, owing to the unequal distribution of the forces. By plotting the lines of equal extension in any given section, he shows some very in-

teresting diagrams, which give a much clearer idea of the nature of the internal strains than could otherwise be had. In some instances it is shown how a reduction in cross-section is accompanied with an actual increase in strength, these theoretical conclusions being fully sustained by actual tests.

A second paper in the same publication, by Herr W. Schule, of Hagen, discusses especially the law of alteration in length of prismatic bodies when subjected to forces producing extension or compression. In this paper many diagrams are given, showing how closely the theoretical curves agree with those obtained by plotting the observations made upon so different materials as granite, rubber, steel, silver, and copper, the data being taken from the experiments of Bach, Winkler, and J. O. Thompson.

A third paper, by Dr. Holzmüller, takes into account especially the conditions existing in thick cylinders, subjected to internal pressure. In order that the reader may obtain a clear idea, he commences by assuming a plate of metal in which a round hole is bored, and considering the conditions which would exist if a steel pin somewhat too large for the hole were driven in.

The plate is supposed at first to be of unlimited area, in which case the radial and tangential stresses are equal to each other, and inversely proportional to the square of the distance from the centre. Taking this as a starting-point, various limiting forms are given to the metal about the hole, and the corresponding distribution of stresses and strains is considered. With these also is considered the case in which two holes are pierced in the plate, and equal distending forces are assumed to be acting in each of them.

The transition from the diagrams constructed upon the assumed plates to the forces in the interior of the metal of a thick-walled cylinder is readily made, and the nature of the problem is much simplified by this method of treatment. In many instances the lines of the forces drawn in accordance with the elastic theory resemble so closely the magnetic lines of force produced by the action of magnetic poles upon surfaces covered with iron filings that the similarity in the actions and conditions is brought to mind.

In all of the papers mentioned a certain amount of mathematical treatment is involved, but in none of them is this sufficient to deter the general reader from gaining much valuable information, and all form important contributions to the study of the strength of materials.

Space Telegraphy at Sea.

IN the last issue we spoke of the desirability of providing some more reliable indicator of the presence of an approaching vessel than any based upon sound, and referred to the possible use of the thermopile for this purpose.

A note presented to the French Academy by M. Branly in connection with a suggestion of MM. Berget and Décombe, and given in *Comptes Rendus*, calls attention to the possibilities of the use of the coherer as an indicator of the approach of a vessel, either at night or during fog.

The method proposed by M. Branly is the very simple one of providing all vessels with at least one transmitter and with several receivers or coherers. Periodical signals being made with the transmitter, corresponding impressions would be made upon the receivers of vessels in season to serve as warning against collision.

The principal difficulty which appears in connection with this idea is the fact that the receivers on any vessel would be affected by the transmitter on the same ship; but there are several methods by which this difficulty may be overcome. The obvious method of using different signals might be employed, or the interval between signals might be chosen to observe the receivers for impressions from approaching ships.

M. Branly, however, calls attention to an observation also communicated by him to the Academy a short time ago, as to the influence of a metallic envelope surrounding a coherer, and shows that, when the coherer is thus completely surrounded, it is unaffected by the influence of a transmitter. By thus enclosing the receivers

on a ship only at the instant of the operation of the transmitter of the same vessel, protection against the influence of the transmitter would be secured, while at the preceding and succeeding moments the coherers would indicate at once the presence of a transmitter on an approaching vessel.

Entire protection against the influence of a neighboring transmitter is attained when the metallic envelope is completely closed, but, by providing a small slit, of adjustable size, various degrees of sensibility may be obtained, and in this manner some estimate of the distance of the influencing transmitter may be made. If the receiver be placed upon an axis and turned, the position of the slit at the moment of strongest influence also furnishes an indication of the direction of the transmitter, and the increasing or diminishing action shows whether the vessel is approaching or receding.

While there seems to be little doubt of the efficacy of this mode of prevention of collisions at sea, it can hardly be considered available unless introduced upon the vessels of all countries. This difficulty also existed in the case of the present foghorns and sirens, however, and, should it be demonstrated that the methods of space-telegraphy can be used with any degree of certainty for the prevention of such disasters as the loss of the Bourgogne, no price within reach would be too high to pay.

The Conservatoire des Arts et Metiers.

THE celebration of the centennial anniversary of the foundation of the great museum of mecha ical and technical models which is contai ed in the buildings of the former priory of Saint Martin-des-Champs at Paris, and now known as the Conservatoire d s Arts et Métiers, is the occasion of the publication in *Le Génie Civil* of an interesting article about the museum and its contents.

The idea of founding a mechanical museum is due to Descartes, but it was not until nearly one hundred and fifty years after his death that the present museum was established, and on 22 Prairial in the year VI according to the republican calendar (June 10, 1798), the National Convention set apart the secularized priory for the purpose.

The nucleus of the incomparable collection now in existence was found in the collections of the two celebrated inventors of the seventeenth century, d'Ons-en-Bray and Vaucanson. Of the two men but little can be said except as to their mechanical ingenuity, the former being a Hollander who, although an amateur, was a most ingenious inventor, while the latter was best known through his very clever automatons. Both left collections of models of much historical interest and value, and these, together with the laboratory apparatus of Lavoisier, the cabinet of Buffon, and the physical apparatus of Charles, fell into the hands of the Convention at the time of the Revolution, and fortunately were preserved as the beginning of the new museum.

Since its foundation the museum has been the recipient of many important and valuable gifts. The minister of public works, for example, has permitted to be deposited there all the fine models of the Ecole des Ponts et Chaussées, including bridges, viaducts, dams, locks, etc. The great works at Creusot has had made, especially for the conservatory, a series of models of the most important of its products, this collection being sufficiently important to have a hall by itself, bearing the name of the donor. Many other additions have been made, and any one who to-day visits the museum finds a wealth of mechanical construction in miniature such as can be found nowhere else in the world.

In connection with the collection of models, the museum has also done excellent work in the department of mechanical instruction, and, as long ago as 1816, courses in applied science were instituted, these being free to the public, and in the hands of eminent scientific men of the day. The original series included only mechanics, chemistry, and industrial economics, but to these were added, in 1836–1839, courses in applied mechanics, descriptive geometry, industrial legislation, applied chemistry, and agriculture. These

were followed at later dates by courses in ceramics, civil construction, textile industry, electricity, metallurgy, etc., until at present there are seventeen distinct courses of study open to the public.

There is not space to discuss the character of the courses thus offered, but the names of some of the eminent men who have acted as instructors will give an idea of the nature of the work done. Among the professors may be found the names of Pouillet, Becquerel, Plante, Peligot, Payen, Boussingault, and Tresca, while among those who have carried on invaluable researches in the laboratories of the museum may be named Leverrier, Violle, and Marcel Deprez.

Not the least interesting feature of the museum is the character of the buildings in which the collection is housed. The library is placed in the former refectory of the priory, and the collection of more than 40,000 volumes forms a valuable reference library, being especially rich in scientific works and in collections of drawings, designs, and diagrams. Among the manuscripts of the library are included a number of mechanical diagrams by Vaucanson, and the autograph letter of Fulton offering his steamboat designs to the French government.

Probably the most remarkable room in the entire museum is the machinery hall, —the former church of the priory. This structure, which is a remarkably fine example of French Gothic architecture, built in the eleventh and twelfth centuries, and attributed to Pierre de Montereau, the architect of the Sainte Chapelle, is now entirely filled with modern machinery in motion, the collection including dynamos, motors, electric lamps, acetylene generators, and machine tools of all sorts. The contrast between the mediæval architecture and the modern machinery is most striking.

In view of the good work which the museum has performed during the first century of its existence, a constantly-increasing influence may be anticipated for the future, and every engineer and mechanic who has had the privilege of visiting this great collection of the products of mechanical science goes away with the feeling that similar museums should form a portion of the educational work in every country.

Tests of Masonry Staircases.

THE Society of Austrian Engineers and Architects has done much to advance the cause of constructive masonry by its carefully-conducted tests upon full-size structures. The tests of masonry arches made several years ago formed the most valuable contributions to that branch of engineering which had been made, and the tests of masonry staircases, a partial report of which appears in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, furnish another example of painstaking research.

The tests were made upon flights of nine steps of dressed sandstone, the upper and lower steps being solidly supported, and the intermediate ones transmitting the forces acting upon them to the upper and lower steps, which acted as abutments. An inclined framework, placed beneath the whole, enabled the deflections to be measured under any given loading, and from the measurements diagrams of the deformations have been constructed.

The tests included the various conditions which may obtain in actual practice, and measurements were made with one or two steps in various parts of the flight loaded, as well as with the full load upon the whole structure. In all cases the loads consisted of piles of pig iron carefully piled upon the steps in such a manner as to insure the desired distribution, and, the correct weight of each pig being known, there was no question as to the actual loads in any case.

In addition to the uniformly-distributed loads placed upon the various portions of the staircase, tests were made of the capacity of the various stones to resist torsion, these tests being made with a lever device which enabled any desired turning moment to be exerted upon one end of a single step, without producing an accompanying bending.

The results, so far as given, are included in tables and diagrams too voluminous to

be reproduced here, but readily available for use and reference in the original publication.

The principal difficulty in the use of these tests as they stand lies in the uncertainty as to the exact equivalent, in other countries, of the especial varieties of stone included in the trials. Apart from this question, which is not of as much importance as it seems to be, the information as to the distribution of pressure and the nature of deflection is very general in its nature, and forms an important contribution to the common stock of knowledge in building construction. So far as the actual strength of the material is concerned, that should be determined by local tests in any case, as the differences between various pieces of the same kind of material are often as great as those found between pieces of different kinds. With a knowledge of the general character of the problem and the possession of a few tests of the immediate material in hand, the constructor can proceed with a fair degree of assurance of the security and stability of his structure.

Telegraphing with Light and Electricity.

ONE of the principal difficulties encountered with the magnetic wave system of space telegraphy, as developed by Lodge, Branly, and Marconi, lies in the fact that the waves are propagated equally in all directions. Attempts have been made to collect and concentrate them by means of concave mirrors and similar devices, but without practical success; hence the electro-magnetic method must be considered to be as yet in the experimental stage.

A new method is now proposed, and discussed at length, in a paper by Herr Karl Zickler in the *Elektrotechnische Zeitschrift*, in which a principle discovered by Hertz in 1887 as to the influence of certain short-wave-length light rays upon electrical discharges is utilized. The most effective rays for this purpose are the ultra-violet, and, as these are transmitted by quartz and obstructed by glass, this fact is utilized in connection with the method of transmission.

The source of light in the transmitter is an arc lamp, the rays from which are reflected and collected by a lens of rock crystal and projected upon the receiver. The latter consists of a glass vessel, closed air-tight at the end by a truly parallel plate of rock crystal, and partially exhausted of air. In front of the receiver is placed a rock crystal condensing lens, and within the exhausted chamber are the two electrodes, one of which is an inclined disc and the other a small ball. These electrodes are connected with the secondary portion of an induction coil, and, when the ultra-violet rays fall upon the inclined disc and are reflected to the ball, a discharge will be produced, which may be used either with a telephone, or a coherer to be read.

The signals are sent by alternately interposing a plate of glass in front of the rays issuing from the transmitter, and removing it therefrom, the interruptions corresponding to the make and break of a telegraph key.

Since the glass does not produce any variation in the visual effect of the rays, the signals cannot be read by sight; hence such an apparatus, in the form of a searchlight, might be used to communicate from one ship to another, without revealing the fact to onlookers.

Herr Zickler has made many experiments to verify his conclusions, and appears to have demonstrated the feasibility of his idea in practice.

He is now making the arrangments necessary to carry on further experiments at greater distances than were at first attempted. The early trials were made with a distance of only 50 metres between the transmitter and receiver. It is claimed that, while the distance to which messages may be sent by this system is limited mainly by the strength of the light, it is also dependent to a certain extent upon the nature of the light, the strength of the current, and other conditions.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine, printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

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Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienn
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Asylum.

West Bangour New Lunatic Asylum. Describes a new asylum designed by Hyppolyte J. Blanc, the result of much study and travel, with the aim of making the building as perfect as possible. 1500 w. Arch, Lond—Aug. 12, 1898. No. 22180 A.

Capitals.

Some Capitals in Lincolnshire Bell Towers. An interesting illustrated description of pre-conquest work of various types. 1700 w. Builder—Aug. 6, 1898. No. 22052 A.

Composition.

Principles of Architectural Composition. John Beverley Robinson. General discussion of the subject to aid students. Considers the involved nature of architectural design, the qualities of unity and grace. Ill. 3000 w. Arch Rec—July-Sept., 1898. No. 21893 C.

Concrete Construction.

Constructing a Large Monolithic Concrete Building. Illustrates and describes methods and plant employed on a 200x250-ft. building of concrete reinforced by iron rods. 3800 w. Eng Rec—Aug. 20, 1898. No. 22194.

A Large Monolithic Factory Building. Illustrated description of a 200x250 feet, 4-story building for a quarter of its area, and 1-story elsewhere, built entirely of concrete in which steel rods are bedded. 2500 w. Eng Rec—July 30, 1898. No. 21811.

Courthouse.

The Construction of Courthouse Buildings. (Ueber den Bau von Gerichtsgebäuden.) A. von Wielemans. With especial reference to public buildings in Austria, including plans of the court houses at Graz and at Olmutz. 5000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—July 15, 1898. No. 22318 B.

Domestic Architecture.

An Architectural Experiment. R. A. C. Illustrates and describes an attempt to adapt Japanese architecture to the climatic and other conditions of a Massachusetts home, that the house might be in keeping with its oriental furnishings. 2000 w. Arch Rec—July-Sept., 1898. No. 21895 C.

English Habitations. A review of the progress of architecture in England from earliest times to the reign of Charles I. 4000 w. Arch, Lond—Aug. 12, 1898. No. 22181 A.

Fireproofing.

Fire-proof Buildings. Francis C. Moore. Extracted from the publications of the British Fire Prevention Committee. Discusses the precautions that should be taken in the construction of these buildings, and the dangers that threaten. 2600 w. Can Eng—Aug., 1898. Serial. 1st part. No. 21996.

Progress in the Application of Fireproofing to Structural Iron Work. (Die Fortschritte in der Anwendung und Erfahrungen über die Feuersicherheit des Eisens im Hochbau.) W. Linse. An examination into the value of various fireproofing materials, showing apparatus for testing the strength of iron columns when covered and subjected to heat. Serial. 1st part. 3500 w. Stahl und Eisen—Aug. 1, 1898. No. 22357 D.

Security Against Fire. A paper entitled "Lessons from Fire and Panic," read by Thomas Blashill before the Surveyors' Inst., and published by the British Fire Prevention Committee. Calls attention to details often neglected, which are essential for the protection, and the construction of fire-resisting buildings. 3000 w. Arch, Lond—Aug. 12, 1898. No. 22182 A.

Foundations.

Caisson Foundations. Illustrated description. 1500 w. Eng Rec—July 30, 1898. Serial. 1st part. No. 21812.

House Planning.

Common-Sense Planning. Russell Sturgis. Suggestions on planning houses, studying exterior and interior effect, and discussing some arrangements given as illustrations. 4800 w. Arch Rev—Vol. V, No. V—1898. No. 21900 F.

Ice Houses.

Construction of Small Ice Houses. Recommendations from the report of committee appointed by the Assn. of Ry. Supts. of Bridges and Buildings of the United States. 1000 w. Ice & Refrig—Aug., 1898. No. 21829 C.

Jubilee.

The Jubilee Exposition of 1898 in Vienna. (Jubiläums-Ausstellung 1898 in Wien.) Description and illustration of the handsome pavilion of the City of Vienna, erected in honor of the Imperial Jubilee. 1200 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1898. No. 22369 D.

Libraries.

New Ideas in Library Buildings. William E. Foster. Extract. Considers some details of the architecture and arrangement of libraries. 1800 w. Am Arch—July 30, 1898. No. 21871.

Milan.

Milan Cathedral. Introductory remarks on the many architectural works of interest in the city, with account of the magnificent Gothic structure—the Cathedral dedicated to St. Mary. 1600 w. Am Arch—Aug. 6, 1898. No. 22002.

Modern Architecture.

Good Things in Modern Architecture. Russell Sturgis. Illustrated description of recent work with critical comment. 5800 w. Arch Rec—July-Sept., 1898. No. 21896 C.

Ornament.

A Study of Evolution, Persistence, and Reversion in Ornament Motives. A. D. F. Hamlin. An interesting study of the origin and de-

velopment of decorative designs. Ill. 5500 w. Arch Rec—July-Sept., 1898. No. 21894 C.

St. Martin's.

St. Martin's, Canterbury. Review of a work by Rev. C. F. Routledge, giving something of its history and construction. 2800 w. Builder—July 30, 1898. No. 22007 A.

Staircases.

Report Upon the Thrust of Staircases. (Bericht des Stiegenstufen Ausschusses.) Prof. J. E. Brik. An illustrated report of the tests made by the Austrian Society of Engineers upon the behavior of a flight of masonry steps under various conditions of loading and material. A valuable paper. Two articles. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—August 5, 12, 1898. No. 22323 each B.

Steel-Cage Building.

The De Dino Building, New York City. Illustrated description of steel-cage and steel-grillage work in a 13-story office building. 500 w. Eng Rec—Aug. 15, 1898. No. 22095.

Suburban Home.

Suburban Residence Built of Brick. Charles A. Rich. An interesting illustrated description of a very artistic home. 2000 w. Br Build—Aug., 1898. No. 22229 C.

Underpinning.

Underpinning of St. Mary Woolnoth. Illustrations showing interesting engineering work being carried on in London, made necessary by the extension of the City and South London Ry., underground. The Lombard-street station will be situated under this church. 1600 w. Engng—July 29, 1898. No. 21960 A.

Workmen's Homes.

The Housing of the Working Classes Act (1890) in Edinburgh. William Bruce. An account of improvements made and projected for the benefit of the laboring class. 2200 w. San Rec—July 22, 1898. No. 21823 A.

Workmen's Dwellings in Belfast. James Munce. Interesting notes on the improved dwellings, almost every family occupying one house. Ill. 2800 w. Jour of San Inst—April, 1898. No. 21858 G.

HEATING AND VENTILATION.

Cold Storage.

Cold Storage. Comments on Prof. Rane's experiments, giving extracts from his paper read before the Philadelphia Society for the Promotion of Agriculture. 1000 w. Ice & Refrig—Aug., 1898. No. 21828 C.

Fans.

Fans and Blowers. J. H. Kinealy. On the theory of the action of the ordinary centrifugal type of fan or blower. 1000 w. Heat & Ven—Aug. 15, 1898. No. 22206.

Some Experiments Upon Ventilating Fans. W. G. Walker. Abstract of a paper recently read before the British Inst. of Mech. Engs., giving an account of late experiments and their results. 1600 w. Eng Rec—Aug. 6, 1898. No. 21990.

Germs.

Making Human Abodes Germproof. Frederick Baumann. Suggestions for the protection of foundations, and sewer and water pipes. 1400 w. Dom Engng—Aug., 1898. No. 22100 C.

Hospital.

Ventilating and Heating a New York Hospital. Illustrated description of an interesting application of the indirect hot-blast system in the Hospital for the Ruptured and Crippled. The ventilation is effected by the use of exhaust fans placed on the roof. 1300 w. Eng Rec—Aug. 6, 1898. No. 21991.

Hot-Water.

Hot-Water Heating in a New York Residence. Illustrated description of a plant with an unusual amount of indirect heating installed under difficult conditions. 1300 w. Eng Rec—Aug. 20, 1898. No. 22195.

Schools.

Heating and Ventilating Apparatus for Public School Building No. 122, Northeast Corner First Ave. and Ninth St., New York City. Illustrated detailed description. 8500 w. Heat & Ven—Aug. 15, 1898. No. 22205.

Heating the Eastern Illinois State Normal School. Illustrated description of a building heated and ventilated by what is known as the double type of the plenum system. 1000 w. Met Work—Aug. 13, 1898. No. 22043.

Steam Heating.

A Plan for Increasing the Capacity of the Steam Heating Plant of the Spooner Library, University of Kansas. Frank E. Ward. Showing how a difficulty in forcing the steam over to the library from the boiler-house was overcome. Ill. 900 w. Kansas Univ Quar—July, 1898. No. 22215 D.

Ventilation Tests.

Some Accepted Tests on Ventilation—Are They Reliable? T. C. Northcott. Discusses the shortcomings of tests in use, though recommending their use until less defective methods can be substituted. 1800 w. Dom Engng—Aug., 1898. No. 22103 C.

PLUMBING AND GASFITTING.

Court Decision.

The Municipal Plumbing Business of Waycross. Review of a decision of the Georgia Supreme Court prohibiting plumbing by city officials. 700 w. Eng Rec—July 30, 1898. No. 21807.

Drainage.

Drain Testing. J. Spottiswoode Cameron. Some facts revealed by testing the drains of 1121 houses in which typhoid and diphtheritic disease was thought to be present. 1500 w. Jour of San Inst—April, 1898. No. 21859 G.

Error in Drainage Practice. W. M. Watson. Showing the evils of using too many drain traps and using drains of too large size. 1000 w. Can Eng—Aug., 1898. No. 21994.

Education.

Science and Plumbers' Work. P. Phillips

Bedson. From a lecture delivered before the North of England Dist. Council, Nat. Registration of Plumbers. Brief suggestion for the education of plumbers, and the need of some knowledge of the sciences to understand the problems to be worked out. 1500 w. San Plumb—Aug. 1, 1898. No. 21881.

Hotel.

An Extensive Plumbing Job. Account of the plumbing and heating of the Hotel Sterling at Wilkes Barre, Pa. 350 w. Metal Work—Aug. 27, 1898. No. 22254.

Lead Work.

A Notable Piece of Lead Tank Work. An illustrated account of the lining of the immense tanks in Madison Sq. Garden, New York, arranged for the presentation of imitation battles for public entertainment. 700 w. Met Work—Aug. 13, 1898. No. 22044.

Plumbing Details.

Some Plumbing Details in Columbia University Gymnasium. Part first gives an illustrated general description of the work. 1000 w. Eng Rec—Aug. 27, 1898. Serial. 1st part. No. 22278.

Sanitation.

Relation of Plumbing to Health. Albert E. Hyde. The important part plumbing bears to the prevention of disease is shown. 1600 w. Dom Engng—Aug., 1898. Serial. 1st part. No. 22102 C.

Trade Schools.

The Proficiency of the Trade School Plumber. An account of one test applied to the students in their final examination. Ill. 700 w. Met Work—Aug. 27, 1898. No. 22253.

MISCELLANY.

Architects' Charges.

The Schedules of Charges of British and German Architects. Gives schedules adopted by the Royal Institute of British Architects and the German Society of Architects and Engineers. 2000 w. Eng Rec—Sept. 3, 1898. No. 22536.

Architects' Responsibilities.

Architects' Legal Responsibilities. Review of decision of Michigan Supreme Court on an architect's responsibility for unsatisfactory details. 800 w. Eng Rec—Aug. 27, 1898. No. 22268.

Brisbane.

Brisbane. Some interesting information of the architecture of this capital city of Queensland, Australia. Ill. 2300 w. Builder—Aug. 20, 1898. No. 22415 A.

Ceilings.

Something About Ceilings. From L. A. Shuffrey's paper on "House Decoration." Discusses how to prevent cracking of the plaster, finishing, treatment of old ceilings, ornament, &c. 1000 w. Plumb & Dec—Aug. 1, 1898. No. 22042 A.

Decoration.

The Use of Smoothing Materials and the Decoration of Highly Finished Surfaces. Walter J. Pearce. Suggestions for the finishing of painted surfaces. Ill. 2000 w. Plumb & Dec—Aug. 1, 1898. No. 22041 A.

Dundee.

The Architecture of Our Large Provincial Towns—Dundee. Illustrates and describes the architecture, gives brief history of the place, and remarks its recent growth. 9500 w. Builder—Aug. 13, 1898. No. 22169 A.

Earthquake Districts.

Buildings in Earthquake Districts. Note on the proceedings of a committee to inquire into the question of the most suitable types of buildings in districts liable to earthquakes. 1800 w. Ind Engng—July 28, 1898. No. 22221 D.

Educational.

The Columbia University School of Architecture. William R. Ware. An explanation of the work being done for professional draughtsmen. 2500 w. Am Arch—Aug. 6, 1898. No. 22001.

Estimating.

Estimating Brickwork. F. E. Kidder. Explains the system adopted by the Brick Contractors' Exchange of Denver, and illustrates its application. 1200 w. Br Build—Aug., 1898. Serial. 1st part. No. 22231 C.

Floors.

Hardwood Floors. Edgar J. Spratling. Suggestions for the selection of flooring, and the laying, finishing and care. 1500 w. Am Arch—Aug. 20, 1898. No. 22184.

Fresco.

Leon Batista Alberti on Fresco. Concerning the coats of plaster, how the mortar is to be prepared, statues, bas-relief and pictures for adornment. 1800 w. Arch, Lond—Aug. 19, 1898. No. 22418 A.

Halicarnassus Mausoleum.

Cockerell on the Mausoleum. A description by C. R. Cockerell, of an attempt to restore the Mausoleum at Halicarnassus. 1300 w. Arch, Lond—Aug 5, 1898. No. 22077 A.

Jefferson.

Jefferson as Architect. Elizabeth Porter Gould, in the *Boston Evening Transcript*. Describes the beautiful architecture of the University of Virginia, at Charlottesville. 1500 w. Arch & Build—Aug. 27, 1898. No. 22245.

Kentucky.

The Clays and Building Stones of Kentucky. M. H. Crump. Deals principally with the value of the clays for pottery, brick, &c., referring briefly to the excellent quality of the building stone. 1300 w. Eng & Min Jour—Aug. 13, 1898. No. 22089.

Revised Schedule.

The Professional Practice as to the Charges of Architects. Schedule sanctioned by the Royal Inst. of British Architects, confirmed at a general conference of architects of the United Kingdom, 1872, and revised by the Royal Institute 1898. Also discussion. 9000 w. Jour Roy Inst of Brit Archs—July 23, 1898. No. 22413 B.

CIVIL ENGINEERING.

BRIDGES.

Alexandre III.

The Construction of the Alexandre III Bridge at Paris. (Construction du Pont Alexandre III.) MM. Résal and Alby. Description of the site, and an account of the progress of the work up to the present time, with especial reference to the sinking of the caissons and the construction of the foundations. 15000 w. 7 plates. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22337 F+G.

Arch Bridge.

The Fairmount Park Arch Bridge, Philadelphia. Illustrates and briefly describes the principal constructional features. 900 w. Eng News—Aug. 4, 1898. No. 21940.

Bridge Erection.

An Adjustable Steel Traveler. Illustrated description of a traveler capable of adjustment for bridges of various sizes and of ready shipment. 1000 w. Eng Rec—July 30, 1898. No. 21808.

The Erection of the Omaha Bridge. Illustrated description of the methods and plant used to remove the old and erect the new Union Pacific Bridge. 1500 w. Eng Rec—Aug. 27, 1898. No. 22271.

Bridge Failure.

Bridge Failure at Utica, N. Y. An account of a bridge breaking down under a street-car, with hypothesis explaining a possible cause. 1200 w. R R Gaz—Aug. 19, 1898. No. 22127.

Bridge Removal.

The Removal of an Iron Bridge. (Verschiebung einer Eisernen Brücke.) Describes the manner in which an iron truss bridge of 107 feet span and over 70 tons weight was shifted bodily to a new location about 100 feet distant in 30 minutes. Photographs of various stages of the work are given. 1000 w. Glaser's Annalen—July 15, 1898. No. 22360 D.

Brooklyn Bridge.

Buckling of Trusses on Brooklyn Bridge. Editorial on the recent anxiety concerning the safety of this bridge, describing the cause of the buckling of the four main trusses. 500 w. R R Gaz—Aug. 5, 1898. No. 21927.

Concrete Bridge.

Concrete Bridge Over the Towy. Illustrates and describes a design offered by G. A. Lundie, but not accepted by the council, giving specification. 1000 w. Engr, Lond—July 22, 1898. No. 21838 A.

Construction.

European and American Bridge Construction. Gustav Lindenthal. A fully illustrated paper, showing the rise of metallic bridge construction and the development and extension of modern methods to wide spans. 3500 w. Engineering Magazine—September, 1898. No. 22382 B.

Drawbridge.

An Electrically-Operated Drawbridge. Walter Kidde. An illustrated description of the motive power used in operating a 450-ton drawbridge over the Passaic River, at Newark, N. J., with statement of the requirements so successfully met. 1000 w. Stevens' Ind—July, 1898. No. 21852 D.

Gogra Bridge.

Gogra Bridge, Bohramghat. W. J. Turnbull. Illustrated description of a bridge over a river with badly defined banks. 400 w. Ind Engng—July 23, 1898. No. 22006 D.

Highway Bridge.

The West Braddock Bridge. Illustrated description of the design and erection of a bridge, near Pittsburg, with about 900 feet of plate girder spans, and river spans of 515, 489 and 252 feet. The expansion pockets and several other details are novel. 1700 w. Eng Rec—Aug. 13, 1898. No. 22092.

New South Wales.

Public Works in New South Wales. Brief illustrated description of a suspension bridge across Kangaroo Valley. 500 w. Arch, Lond—Aug. 19, 1898. No. 22417 A.

Railway Bridge.

Assam-Bengal Railway Bridges. Sketch design of the steel trestles of a bridge on a 10° curve, radius 573 feet, on a grade of 1 in 43, with specifications. 1000 w. Ind Engng—July 9, 1898. No. 22039 D.

Bridge Work on the Kansas City, Pittsburg and Gulf R. R. Illustrates and describes the Waddell patented form of 100-ft. through truss, the concrete piers of the Arkansas River bridge and the construction of these piers, with the engineering difficulties encountered and overcome. 6300 w. Eng News—Aug. 25, 1898. No. 22, 227.

Light Railway Bridges. The Lössintz bridge on the Eppendorf-Hetzdorf state railway line, in Saxony, is illustrated and described as a noteworthy type. 1500 w. Engr, Lond—July 22, 1898. No. 21843 A.

New Railway Bridge Over the Seine. Brief illustrated description. 700 w. Engr, Lond—Aug. 19, 1898. No. 22405 A.

Suspension.

Acceptance Tests of the Suspension Bridge at Saint-Vallier. (Les Epreuves de Réception du Pont Suspender de Saint Vallier.) Report showing deflections for various positions of concentrated moving loads. The bridge is double-span, with tower in centre. 7500 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22333 F + G.

Truss Work of Rigid Suspension Bridges. (Garde Corps des Ponts Suspendus Rigides.) M. Métour. A mathematical discussion of the stresses in the framed truss-work of a rigid suspension bridge, with tables of bending and shearing moments. 5000 w. 1 Trimestre, 1898. No. 22335 F+G.

Swing Bridge.

"Bobtail" Swing Bridge, Santa Fé Ry., Le-

mont, Ill. Illustrates and describes a double-track bridge about to be erected by the Sanitary District of Chicago, over the main channel of the drainage canal. 1200 w. Ry & Engng Rev—Aug. 6, 1898. No. 21993.

Viaduct.

The Construction of the Viaur Viaduct. (Construction du Viaduct du Viaur.) MM. de Volontat and Théry. An account of the progress of the construction of the piers and scaffolding for this great railway arch over the Viaur valley, in the south of France. 2500 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22338 F + G.

CANALS, RIVERS AND HARBORS.

Breakwater.

The New Cleveland Breakwater. Illustrated description of its design and construction. 3500 w. Eng Rec—Aug. 20, 1898. No. 22191.

Bristol Docks.

The Bristol Docks and River. Editorial discussing the proposed improvements of this port, and how the matter now stands. 1800 w. Engr, Lond—Aug. 5, 1898. No. 22059 A.

Canal Travel.

Passenger Travel on Canals. Reviews some of the types of boats used on British canals for passenger traffic, when this was the popular way of travelling. 1400 w. Engr, Lond—July 22, 1898. No. 21844 A.

Dam.

The Elastic Equilibrium in a Masonry Dam of Triangular Section. (Sur l'Equilibre Elastique d'un Barrage en Maçonnerie à Section Triangulaire.) A communication by M. Maurice Lévy, containing a mathematical discussion based upon the elastic theory, and enabling the forces to be computed with a high degree of accuracy. 2500 w. Comptes Rendus—July 4, 1898. No. 22342 D.

Partial Failure of Timber Dam near Butte, Mont. M. S. Parker. Illustrates and describes the injury that occurred during a period of high water, lasting for several days, showing that care should be taken to secure sufficient bearing surface for the timbers composing the crib to support the pressure and take up the compression. 1200 w. Eng Rec—Aug. 6, 1898. No. 21987.

Dortmund.

The Dortmund-Ems Canal. (Der Kanal von Dortmund nach den Emshäfen.) General description of this important waterway, with map, profile, and views of bridges and locks. Two articles. 5000 w. Deutsche Bauzeitung—July 23, 27, 1898. No. 22348 each B.

Dredging.

The Great Sea-Going Dredges on the Mersey Bar, Liverpool. An illustrated description of the sea-going dredge "Brancker" and its work, with an interesting account of the circumstances which led to its construction. 2000 w. Sci Am—Aug. 27, 1898. No. 22233.

Floods.

On Fighting Floods. Describes the rivers of India, classifying them as the tidal, the deltaic, the semi-deltaic, and the torrential. Discusses the crossing of these rivers and the protection of the structures. 5600 w. Ind & East Eng—July, 1898. No. 22133 D.

France.

Improvement of the System of Canals from Paris to the north of France. (Verbesserung der von Nord-Frankreich gegen Paris führenden Schiffahrts-Canale.) A. Dumas. With map of existing and projected works and a statement of past and present tonnage. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1898. No. 22370 D.

Harbor Improvement.

Boulogne Harbor. Describes the improvements carried out since 1878, the cost, the machinery and working conditions of the port, navigating conditions, towing service, pilots, &c. Ill. 3000 w. Engr, Lond — July 22, 1898. No. 21840 A.

Changes in Madras Harbor and Roadstead. A recent survey has been made of this harbor, and reported information is given, with discussion of causes, comparison with previous reports, &c. 1800 w. Ind Engng—July 23, 1898. Serial. 1st part. No. 22222 D.

The Port of Calais. An illustrated account of the improvements and extension of this port, the plant and machinery. 2000 w. Engr, Lond—July 22, 1898. No. 21837 A.

Harbor Lighting.

The Electric Lighting of the Port of Rouen. (Eclairage Electrique du Port de Rouen.) M. Chateau. Especially devoted to the stationary arc lights disposed about the docks and quays of the left bank of the harbor. 3500 w. 3 plates. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22334 F + G.

Hydraulic Observations.

The Practical Value of Water-Level Observations. (Beitrag zur Praktischen Verwertung der Wasserstands-Beobachtungen.) A. Herbst. An examination of the systematic records of river levels and a discussion of the method of comparing diagrams of such records to obtain average results. 10000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1898. No. 22371 D.

Leith.

The Docks of Leith. Gives briefly the history of the construction of the docks now in existence, and the new dock works now being constructed. 2700 w. Engr, Lond—July, 22, 1898. No. 21842 A.

New York Canals.

Recent Engineering on the New York State Canals. Extract from report by E. P. North and L. E. Cooley concerning the present administration of the State Engineer's office. 1200 w. Eng Rec—Aug. 20, 1898. No. 22190.

The Canal Commissioners' Report. A summary of the report of the commission, appointed to investigate matters relating to the New York State canals, with editorial comment. 6000 w. Sea—Aug. 11, 1898. No. 22033.

The New York State Canal Inquiry. An abstract of the report of commission appointed by

the governor to investigate the work done under the $9,000,000 appropriation, with editorial comment. 4700 w. Eng News—Aug. 11, 1898. No. 22046.

Nicaragua.

The Nicaragua Canal. Editorial comment on statements made in urging the need of this canal, and the United States duty concerning it. 1000 w. R R Gaz—Aug. 12, 1898. No. 22037.

River Improvement.

The Correction of the Rhine in the St. Gall-Vorarlberg Valley. (Die Korrecktion der Gewässer im St. Gallisch-Vorarlbergischen Rheinthale.) J. Wey. An account of the improvements of the Rhine as it enters the Lake of Constance including the reinforcing of the banks and the straightening of the channel by extensive canal works. Two articles. 1 plate. 4000 w. Schweizerische Bauzeitung—July 16, 23, 1898. No. 22361 each B.

Weirs.

The Sidhnai Weir, River Ravi, Punjab. An interesting description with illustrations. 2000 w. Ind & East Eng—July, 1898. No. 22135 D.

IRRIGATION.

Seepage.

Seepage from Canals. Review of important investigations showing that in Colorado alone water worth $6,000,000, at least, is lost through leakage from ditches. 1200 w. Eng Rec—Aug. 27, 1898. No. 22275.

MISCELLANY.

Cement.

Tensile Tests of Cement. Ira O. Baker. A complete statement of the method of making the tests, calling attention to such variations in practice as are in common use. Part first deals with tensile tests. 2500 w. Br Build—Aug., 1898. Serial. 1st part. No. 22230 C.

The Definition of Portland Cement. Jasper Whiting. Argument that slag cements should be classed as Portlands. 2200 w. Eng Rec—July, 30, 1898. No. 21810.

The Value of Extreme Fineness of Grinding for Hydraulic Cement. A study of this subject demonstrating the advantage of fine grinding, but showing that it is accompanied with disadvantages. 2200 w. Eng News—Aug. 18, 1898. No. 22122.

Contractor.

How to Become a Successful Contractor. Alexander MacLachlan. A few hints from one who has had twenty-five years experience. 2200 w. Builder—Aug. 20, 1898. No. 22416 A.

Elasticity.

Concerning the Law of Elastic Longitudinal Deformation. (Ueber das Gesetz der Elastischen Längenänderung Prismatischer Körper durch Zug und Druck.) W. Schüle. With many diagrams constructed from tests of materials by various observers, showing the close relation between computed and observed results. 3000 w. Zeitschr d Ver Deutscher Ing—July 30, 1898. No. 22312 D.

The Theory of Elasticity and the Study of the Strength of Materials. (Die Theorie der Elastizität, und die Bedurfnisse der Festigkeitslehre. Dr. Kirsch. A mathematical investigation of the modern theory showing its application to practical problems, as well as the close agreement between observed and computed results. 9000 w. Zeitschr d Ver Deutscher Ing—July 16, 1898. No. 22303 D.

Engineers.

The Position of United States Assistant Engineers. Editorial discussion of the position and pay of these engineers and what ought to be done to bring about a just recognition and compensation. 3000 w. Eng News—Aug. 4, 1898. No. 21943.

Foundations.

See Architecture and Building, Construction.

French Society.

The French Society of Civil Engineers. History of this society, which has recently celebrated its fiftieth anniversary, with illustrations of its new building. 3300 w. Engng—Aug. 5, 1898, No. 22068 A.

Geodesy.

The Remeasurement of the Mackinaw Base Line. Description of the measurement of a 4-mile base line by means of wires of steel and bronze 1-kilometer long. 3500 w. Eng Rec—Aug. 13, 1898. No. 22093.

Land Surveying.

A Case of Jurisprudence in Land Surveying. Ambrose E. Lehman. Gives a description of the work, with a discussion of the questions of jurisprudence involved in the case. Discussion. 8000 w. Pro of Engs' Club of Phila—July, 1898. No. 21971 D.

Reclamation.

Fraser Valley Reclamation. R. E. Palmer. Read before the Canadian Soc. of Civ. Engs. A description of two sluice boxes built by the writer when three different and distinct boxes in each case had succumbed to the effect of freshets. 3500 w. Can Eng—Aug., 1898. No. 21995.

Roads.

Apparatus and Methods Used in Testing Road Building Stone. From a report by T. C. Mendenhall, W. E. McClintock, and C. W. Ross, Highway Commissioners of Mass. Tests described were made to determine the nature of the qualities which constitute fitness or unfitness of different kinds of rocks for road making. 900 w. R R Gaz—Aug. 26, 1898. No. 22252.

Russia.

The Status of the Engineer and Architect in Russia. (Die Standes-und Titel-Verhältnisse der Ingenieure und Architekten in Russland.) A. von Abramson. A general account of the official requirements for these bearing the title of engineer or of architect in the Russian empire, with data about Russian technical schools. 3000 w. Zeitschr d Oester Ing u Arch Ver—July 22, 1898. No. 22319 B.

Stadia Diagram.

A New Stadia Diagram. M. A. Knapp. Sketch and description of a diagram by the use

of which stadia readings may be reduced to true horizontal and vertical distances much more quickly and with a satisfactory degree of accuracy. 1300 w. Eng & Min Jour—Aug 20, 1898. No. 22145.

Stress.

The Conditions of Stress. (Ueber Spannungszustände.) Dr. Holzmüller. A mathematical discussion based both upon the Newtonian and the logarithmic treatment, a number of cases being examined; especial attention is given to thick hollow cylinders subjected to internal pressure. 5000 w. Zeitschr d Ver Deutscher Ing—August 6, 1898. No. 22313 D.

Technical Instruction.

Undergraduate Thesis Work. Edgar Marburg, at Boston meeting of the Soc. for the Promotion of Engineering Education. A protest against making the thesis entirely independent of other undergraduate work. 2500 w. Eng Rec—Aug. 27, 1898. No. 22272.

Transportation.

I. The Improvement of Transportation in Country Districts. E. E. Russell Tratman. A review of possible improvements. II Brick and Macadam Country Roads. J. E. Miller. Report on a hard road construction. III. Improving the Roads of Illinois. J. T. Schmeltzer. With report of committee, and discussion. 8500 w. Ill Soc of Engs & Surv—1898. No. 22212 D.

Tunnels.

Constructing City Street Tunnels. Illustrated description of methods adopted on the Boston subway. 3200 w. Eng Rec—Aug. 20, 1898. No. 22192.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Commerce.

New Opportunities for American Commerce. Worthington C. Ford. Gives a brief review of industrial changes, showing the difficulties to be met in developing the commerce and industry in the far east, and urging rather the looking to Cuba and Porto Rico for new opportunities in trade. 5000 w. Atlantic M—Sept., 1898. No. 22248 D.

American Industries.

American Progress in English Industries. Showing the dangers from American competition, and discussing some of the conditions of labor and other matters affecting production. 1800 w. Engr, Lond—Aug. 19, 1898. No. 22402 A.

Australia.

Australian Market for American Iron and Steel. Some information showing that it would be of advantage to American manufacturers to extend the lines of goods in this market. 1700 w. Am Mfr & Ir Wld—Aug. 19, 1898. No. 22201.

British Trade.

British Trade with This Country. Comments on the one-sided character of our trade. 700 w. Bradstreet's—Aug. 27, 1898. No. 22247.

China.

Our Last Chance in China. W. R. Lawson. Reviews the history of the trade relations between China and England, and discusses the present situation. 6300 w. Bankers' Mag, Lond—Aug., 1898. No. 22003 G.

United States Trade in North China. Extract from the annual report on the trade of China, showing the great importance of the United States trade, which has trebled since 1890. 2300 w. Cons Repts—Aug., 1898. No. 22080 D.

Coal Trade.

Coal in the East. Editorial showing that the supplies of coal from Japan, British India, and China must soon cause keen competition in eastern markets. 1200 w. Engng—Aug. 5, 1898. No. 22072 A.

Competition.

American Competition in China and Japan. Points from the report of the British Consul at Washington, showing that the United States is likely to be the greatest competitor of Britain in the Far East. 1700 w. Ind & East Eng—July, 1898. No. 22134 D.

Consular Reports.

Consuls and Foreign Trade. Editorial comment on the growing use of the consular reports, and on other matters that are helpful to foreign trade. The importance of acquiring the languages, the adapting of goods to the purchaser's needs, careful packing, &c., are considered. 1800 w. Engng—July 22, 1898. No. 21847 A.

Free Trade.

Free Trade and Foreign Policy. J. A. Hobson. Discusses the theory of free trade in England, examining the fundamental assumptions of the policy, and arguing that English prosperity does not depend upon continual expansion of foreign trade. 5000 w. Contempory Rev—Aug., 1898. No. 22021 D.

Great Lakes.

Statistics of Commerce on the Great Lakes. Statements from an interesting report issued by the Bureau of Statistics of the U. S. Treasury Dept. upon the growth of the traffic, and the reasons for it. 2300 w. Eng News—Aug. 11, 1898. No. 22047.

The Great Lakes and Our Commercial Supremacy. John Foord. An interesting account of the improvements that have made the transportation of ore through the Great Lakes so cheap as 'to make the primacy of the United States in the production of iron and steel secure, and the increase in trade due to the development of the trade of Lake Superior. 4500 w. N Am Rev—Aug., 1898. No. 21891 D.

India Rubber.

Investigations upon the Milk of Rubber Plants. (Recherches sur les Laits de Caoutchouc.) A posthumous paper from the documents of M. Aimé Girard, giving analyses of the milk of a variety of rubber plants, showing the proportion of caoutchouc, and the general properties of each. 3000 w. Bull de la Société d'Encour—July, 1898. No. 22341 G.

Sources of Commercial India-Rubber. Dr. D. Morris. A series of lectures confined to an investigation of the rubber plants now existing in various parts of the tropics, their geographical distribution, the conditions under which they grow, and the prospects they afford of being able to meet the increasing demand for rubber. Ill. 6700 w. Jour Soc of Arts—July 29, 1898. Serial. 3 parts. No. 21-953 each A.

Iron Trade.

Review of the American Iron Trade in 1897 and in the First Seven Months of 1898. From the Annual Statistical Report of the American Iron and Steel Assn. for 1897. Low prices and the cause; great increase in exports; remarkably active consumption. 1000 w. R R Gaz—Aug. 19, 1898. No. 22129.

Japanese Investments.

Foreign Capital and Japanese Investments. Considers what will be the conditions under which foreign capital can be invested in Japan when the revised treaties have come into force. The law and the spirit in which it is likely to be administered are discussed. 3300 w. Engr, Lond—Aug. 5, 1898. No. 22058 A.

Korea.

Trade of Korea in 1897. Reports this as the most prosperous year for foreign trade, almost double the highest figure previously reached, with explanation of the increase. 4500 w. Cons Repts—Aug., 1898. No. 22079 D.

Pacific Commerce.

Commerce and Its Possibilities in the Pacific. Presents some figures given in an article in the London *Statist*, and discusses the commercial possibilities. 900 w. Bradstreet's—Aug. 20, 1898. No. 22136.

Petroleum.

The Defeat of the Oil-Kings. Robert Donald. Discussion of the report of the select committee appointed by the English House of Commons, why it was appointed, the problem to be solved, the evidence, &c. 6000 w. Contemporary Rev—Aug., 1898. No. 22022 D.

Philippines.

The Philippine Islands. Discusses the importance of these islands because of their geographical position, their trade, and the difficulties likely to arise in solving the question of their fate. 1300 w. Engng—Aug. 12, 1898. No. 22160 A.

Porto Rico.

Porto Rico's Commerce. Some statistics of the foreign trade of the island, the leading products, exports and imports. 1000 w. Sci Am—Aug. 20, 1898. No. 22111.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce and Meats. Tabulated statement with report of the upward tendency of prices. 3500 w. Bradstreet's—Aug. 6, 1898. No. 21934.

Russia.

The Giant of the East. Discusses the great progress made by Russia of late years, not only in political and diplomatic affairs, but in the paths of industry and trade. 1500 w. Bradstreet's—July 30, 1898. No. 21822.

Trans-Siberian.

The Trans Siberian Railroad. Calls attention to the probable effect of this road on American commerce. 800 w. Bul of Bureau of Am Rep—July, 1898. No. 22004 C.

U. S. Commerce.

United States Bureau of Foreign Commerce. A brief account of what is being done in the U. S. in furnishing information helpful to trade. 1000 w. Engng—Aug. 19, 1898. No. 22293 A.

GOVERNMENTAL CONTROL.

Governmental Control.

Railroads and the Government. B. W. Arnold, Jr. Discussion of the railway problem looking toward an increase in governmental control, but offering little in the way of new suggestions. 2500 w. Gunton's Mag—Aug., 1898. No. 21851 C.

LABOR.

Compensation Act.

Workmen's Compensation Act. From the London *Times*. Explains a new departure on the part of the insurance companies undertaking insurance against employers' liability under this act. 800 w. Arch, Lond—Aug. 5, 1898. No. 22078 A.

Dangerous Employments.

Commercial Manslaughter. Gertrude Tuckwell. Describing the pitiful suffering of the workers in English potteries, and the apathy of those responsible for the conditions. 2500 w. Nineteenth Cent—Aug., 1898. No. 22019 D.

Hours and Wages.

A Five Years' Comparison of Labor as Regards Hours and Rates of Wages. Interesting information from the Fifth Annual Report of the Labor Department of the British Board of Trade. 1800 w. Ir & Coal Trds Rev—Aug. 19, 1898. No 22401 A.

Modern Industry.

Problems of Modern Industry. Reviews a recent book by Sidney and Beatrice Webb,—collection of essays and addresses on industrial problems, especially in England 1700 w. Builder—July 30, 1898. No. 22008 A.

Organized Labor.

The Relation of Municipalities to Organized Labor. James A. Lavery. Opposes the contract system, favors municipal ownership, favors the use of the union label. 4800 w. Pro Age—Aug. 15, 1898. No. 22096.

Southern Women.

Opportunities for Southern Women. Jerome Dowd. States the peculiar conditions which make the opportunities for employment of poor white women very much circumscribed. 1700 w. Gunton's Mag—Sept., 1898. No. 22427 C.

Wages.

Are Wages Really Falling? Discusses the report on comparative wages and prices, 1860 to 1897, as given by the Massachusetts Labor Bureau. 3500 w. Gunton's Mag—Aug., 1898. No. 21850 C.

MISCELLANY.

Arbitration.

The Anglo-American Joint High Commission. Discusses some of the questions to be brought before this Commission, and the importance of its labors. 4300 w. N Am Rev—Aug., 1898. No. 21892 D.

Combination.

The New Steel Combination. Editorial on the consolidation of the Illinois Steel Co. and the Minnesota Iron Co., with possibly other additions. 1000 w. Eng & Min Jour—Aug. 27, 1898. No. 22255.

Education.

A Higher Industrial and Commercial Education. J. B. Johnson. Abstract of the presidential address before the Society for the Promotion of Engineering Education, Boston. Describes the German mono-technic schools, considering them the explanation of that country's wonderful advancement during the last quarter century, and urges a specific scientific training for the directors of every kind of commercial and manufacturing industry in America. 3500 w. Eng News—Aug. 18, 1898. No. 22124.

Technical Education. An editorial protest against attempts to combine technical and collegiate subjects. 1400 w. Eng Rec—Aug. 20, 1898. No. 22188.

Patent Law.

Some Comparative Points of International Patent Law. J. Sinclair Fairfax. A review of the leading international features of patent law, with especial reference to the practice in England and America. 3500 w. Engineering Magazine—September, 1898. No. 22385 B.

Trusts.

Trusts vs. the Town. C. D. Chamberlin. An article discussing the effect of trusts on the rural town, with editorial reply. 2800 w. Gunton's Mag—Sept., 1898. No. 22426 C.

U. S. Manufacturing.

Distribution of Manufacturing in the United States. Cyrus C. Adams. Showing some of the causes that have determined the location and distribution of manufacturing industries. 3000 w. Chau—Sept., 1898. No. 22289 C.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Ammonium.

Ammonium Amalgam. H. C. Pocklington. Investigations of the substance known by this name with a view to settling questions relating to its character. 1200 w. Elect'n, London—July 29, 1898. No. 22009 A.

Carborundum.

Carborundum. An illustrated description of the processes used at Niagara in the manufacture of this product. 2000 w. Am Mach—Aug. 11, 1898. No. 22024.

Chromium.

The Electrochemical Behavior of Chromium. From the *Electrician*, London. Some facts obtained from the investigations of Prof. Hittorf. 1200 w. Elec, N. Y.—Aug. 3, 1898. No. 21919.

Electrolytic Soda.

The Electrolytic Production of Soda and Bleach by the Hargreaves-Bird Process. Describes the Hargreaves-Bird cell and its action, and other features of the process. 1000 w. Engng—July 22, 1898. No. 21848 A.

Electrolytic Theories.

Electrolytic Theories and Their Relation to Commercial Electro-Chemistry. Edwin Edser. Thinks England does not give the encouragement to investigation that is given by Continental governments, and notes the stimulating influence on the Continent of the theory of electrolytic dissociation in dilute solutions. 1300 w. Elec Eng, Lond—July 22, 1898. No. 21816 A.

Electro-Plating.

Arrangment of an Electro-Plating Plant. T. Ulke. Plan of the plant is given, showing how the dynamo, voltmeter, switchboards, and tanks should be connected, also directions for use and care. 1500 w. Eng & Min Jour—Aug. 6, 1898. No. 21982.

Furnace.

Applications of the Electric Furnace in the Iron Industry. (Les Applications du Four Electrique dans l'Industrie du Fer.) Emile Demenge. Giving many illustrations of historical furnaces, as well as projected devices for iron manufacture. Two articles, 3000 w. Le Génie Civil—July 30, Aug. 6, 1898. No. 22328 each D.

The Utilization of 110-Volt Electric Circuits for Small Furnace Work. Nevil Monroe Hopkins. Describes and illustrates the construction of the furnace, with detailed instructions for making small quantities of calcium carbide. 3000 w. Sci Am Sup—Aug. 27, 1898. No. 22236.

Ozone.

The Production of Ozone, and a Comparison of Its Cost with That of Other Oxidizing Agents. John B. C. Kershaw. A brief de-

scription of each of the different forms of ozonizer now before the public, with an examination of the financial aspects of the use of ozone for various purposes. 2300 w. Elec Rev, Lond—July 29, 1898. No. 22010 A.

Precious Metals.

Notes on the Electro-Chemical Treatment of Ores Containing the Precious Metals. C. E. Webber. Read before the Inst. of Elec. Engs., London. Part first reviews the history of precipitation with the aid of the electric current. Ill. 2500 w. Elec, N. Y.—Aug. 24, 1898. Serial. 1st part. No. 22219.

Tommasi Process.

Electrolytic Processes for the Extraction, Separation and Refining of Metals—The Tommasi Process. D. Tommasi. Illustrated description of this method, with statement of its advantages. 5000 w. Elec Eng, N. Y.—Aug. 11, 1898. No. 22015.

LIGHTING.

Accumulators.

The Use of Accumulators in Connection with Lighting and Traction Systems. John H. Rider. Read before the Municipal Elec. Assn. London. Considers the use of accumulators in the continuous-current lighting station, the alternating-current lighting station, the traction station, and the combined lighting and traction station. 2800 w. Elec, N. Y.—Aug. 17, 1898. No. 22108.

Distribution.

The Zipernowsky-Deri Patent. Full text of this patent for a system of transformer distribution, with both the provisional and complete specification. 4000 w. Elec Eng, Lond—Aug. 12, 1898. No. 22179 A.

Electric Plant.

Some Possibilities with an Electric Lighting Plant. C. O. Poole. Read before the Pacific Coast Gas Assn. Remarks the necessity of carrying an electric-light plant in connection with gas, and the few that pay; then points out errors in construction and operation, and shows how to make the investment profitable. Discussion. 4400 w. Am Gas Lgt Jour—Aug. 12, 1898. No. 22200.

Lamps.

On the Smashing Point of a Glow Lamp. F. W. Carter. The object of the article is to show when, in the life of a lamp, the user will have had the best value for his money. 800 w. Elec Rev, Lond—Aug. 19, 1898. No. 22421 A.

Municipal Lighting.

Municipal Lighting, Colombo. Reports new arrangements which will secure six times the quantity of light for less than the sum paid for the present supply. 1200 w. Ind Engng—July 16, 1898. No. 22140 D.

Paris Station.

A Parisian Electric-Light Station. Illustrations with description of an elaborate installation differing in many respects from American practice. 1000 w. Elec Wld—Aug. 20, 1898. No. 22109.

POWER.

Automobiles.

See Mechanical Engineering, Miscellany.

Conductors.

Aluminum as a Rival of Copper and Brass for Electrical Conductors. Alfred E. Hunt. Gives facts regarding copper and aluminum, in bars, rods, and wire suitable for electrical conductors, and calls attention to the merits of aluminum, stating its advantages and disadvantages. 3000 w. Sci Am Sup—Aug. 20, 1898. No. 22116.

Cranes.

See Mechanical Engineering, Shop & Foundry.

Detroit.

Municipal Lighting in Detroit. A review of the year's operation which shows results favorable to municipal control. 900 w. Eng Rec—Aug. 13, 1898. No. 22090.

Discharges.

The Natural Period of a Transmission Line and the Frequency of Lightning Discharges Therefrom. Charles Proteus Steinmetz. Discusses the frequency of the discharges set up in electrical-transmission lines by lightning and other disturbances. 1500 w. Elec Wld—Aug. 27, 1898. No. 22240.

Dynamos.

Sparkless Reversal in Dynamos. H. N. Allen. From the *Journal of the Institution of Electrical Engineers*. Experiments conducted with the view of finding some of the factors on which the inductance depends, and to see how nearly the results would agree with the theory. 2000 w. Elec Eng, Lond—Aug. 5, 1898. Serial. 1st part. No. 22055 A.

The Measurement of the Efficiency of Dynamos. M. Bunet. Abstract translation of an article in the *Revue de Physique et de Chimie* describing various methods of testing the efficiency and their advantages or disadvantages. 2000 w. Elec Rev, Lond—Aug. 5, 1898. No. 22056 A.

Electric Installations.

Electric Installations on Walenlake, Switzerland. C. Du Riche Preller. Describes the electric launch, Electra, which successfully navigates this lake during the summer season. Also describes the telephone cable at the same place, which is the longest telephone span in Europe. Ill. 1500 w. Engng—Aug. 5, 1898. No. 22073 A.

Electric Plant.

Electric Equipment of the Woodward Mine. W. E. Culbertson. An illustrated description of the plant used for hoisting, haulage and pumping. 1800 w. Mines & Min—Aug., 1898. No. 21951 C.

Electric Supply.

Some Suggestions Relative to Determining the Cost of Electric Supply. M. E. Turner. Abstract of paper read at the convention of the Ohio Elec. Lgt. Assn. Gives illustration of the method of charging a consumer for electrical current based on the cost of the consumer to the supply company. 1200 w. Elec Wld—Aug. 27, 1898. No. 22242.

Electrometer.

A Capillary Electrometer for Electrical Measurements. Charles Frederick Burgess. Read at Omaha meeting of Am. Inst. of Elec. Engs. Calls attention to the applicability of this instrument to practical electrical measurements, giving uses that have been tested. 1800 w. Elec Eng, N. Y.—Aug. 4, 1898. No. 21902.

Generators.

The Calculation of Alternating-Current Generators. Alexander Rothert. Part first discusses the methods of Kapp and Behn-Eschenburg, pointing out the deficiencies which sometimes cause erroneous results, for the purpose of comparison with a theory to be given which is free from such errors. 1500 w. Elec Wld—Aug. 13, 1898. Serial. 1st part. No. 22018.

Induction.

A Small Induction Coil. Howard B. Little. The writer's stated object is to describe in detail a coil whose parts are given definite proportions for definite reasons; with hints suggested by experience in the manufacture, sale and use of such apparatus. Ill. 2300 w. Elec, Lond—Aug. 5, 1898. No. 22023 A.

Interrupters.

Mr. Tesla's Circuit Interrupters. An illustrated description of an extensive line of interrupters lately patented by Nikola Tesla for use in the production of high-frequency currents. 2800 w. Elec Wld—Aug. 20, 1898. No. 22110.

Power Measuring.

See Mechanical Engineering, Power.

Power Plant.

The Clées-Yverdon Electric Power Transmission. (Elektrische Kraftübertragung des Clées-Yverdon.) Illustrated description of this excellent plant near Neuchatel, Switzerland; 1200 h. p. are transmitted about 25 miles. 3500 w. Elektrotech Zeitschr—July 14, 1898. No. 22363 B.

The Electric-Power and Light Plant in the Printing Office of Rudolph Mosse, Berlin. (Die Elektrische Kraft und Lichtanlage in der Buchdruckerei von Rudolf Mosse in Berlin.) B. Stein. An illustrated description of this important establishment; 38 motors of capacity from ½ to 20 h.p. are used to operate printing presses, etc. 3000 w. Zeitschr d Ver Deutscher Ing—July 16, 1898. No. 22304 D.

Power Supply.

Electric Power in Vienna. (Der Elektromotoren-Betrieb in Wien.) Johann Pere. A description of the electric-power-supply companies in Vienna, together with tabulated statement of the extent to which power is used and the various trades among which it is divided. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—July 29, 1898. No. 22321 B.

Pump.

Electric Pump at the Lambrecht Pit. (Pompe Electrique de la Fosse Lambrecht.) Illustrated description of 100-h. p. motor operating triple-cylinder pump at the d'Anzin Mines; an efficiency of 70 per cent. is attained. 1800 w. 1 plate. Le Génie Civil—July 30, 1898. No. 22327 D.

Storage Batteries.

Recent Developments in the Applications of Storage Batteries. Joseph Appleton. Attention is called to the rapid growth during the last three years of this branch of the electrical industry, and to some of the most important and interesting applications developed. Discussion. Ill. 8000 w. Pro of Engs' Club of Phila—July, 1898. No. 21972 D.

Transformers.

Experimental Study of Transformer Diagrams. Harry E. Clifford, Nathan Hayward, and Robert Anderson. Descriptive of tests, with graphical representations. 1200 w. Tech Quar—June, 1898. No. 21819 F.

Transmission.

Long-Distance Transmission of Power. Ernst J. Berg. Abstract of paper read before the Ohio Elec. Lgt. Assn. Discusses the advantages of parallel operation, and the conditions, and disapproves of the growing use of polyphase systems, especially of the two-phase. 2000 w. Elec Wld—Aug. 27, 1898. No. 22241.

The Electrical Transmission of Energy. (Transmissions Electriques d'Energie.) A. Blondel. A very important report upon the entire subject, made by the department of Public Works to the French Chamber of Deputies, to assist in preparing legislation upon the subject. 30000 w. Ann des Ponts et Chaussées—1 trimestre, 1898. No. 22336 F + G.

Snoqualmie Falls Transmission. Illustrated description of plant to utilize the power of these falls and transmit it to Seattle and Tacoma, Washington. 2000 w. W Elect'n—Aug. 20, 1898. No. 22197.

The Mechanicville Transmission Plant. Illustrated description of a Hudson river water-power which will supply current to Schenectady and other nearby places. 1300 w. Elec Rev, N. Y.—Aug. 31, 1898. No. 22423.

TELEGRAPHY AND TELEPHONY.

Cleveland, O.

The Cleveland Telephone Company. Illustrates and describes a modern exchange and its apparatus. 1500 w. Elec Rev, N. Y.—Aug. 31, 1898. No. 22422.

Exposition.

The Telegraph at the Trans-Mississippi and International Exposition. Illustrates and describes the exhibit which shows the present state of perfection attained, and gives much of historical interest. 1400 w. W Elect'n—Aug. 13, 1898. No. 22051.

Fire Alarm.

A Great Advance in Fire-Alarm Telegraph Protection. J. W. Aydon. Read before the Assn. of Fire and Police Telegraph Supts. and Municipal Electricians. Describes a recent advance in methods which makes the outbreak of a fire and the sounding of the alarm simultaneous. 1500 w. Elec Rev, N. Y.—Aug. 24, 1898. No. 22203.

Leakage.

The Interpretation and Correction for Leak-

age of Conductor-Resistance Tests on Submarine Cables. Walter J. Murphy. Gives simple rules and formulæ that have been in constant application for a number of years with most satisfactory results, and proved sufficiently accurate for all practical purposes. 2500 w. Elect'n, Lond—Aug. 12, 1898. No. 22173 A.

Light Telegraphy.

Telegraphy with Light and Electricity. (Lichtelektrische Telegraphie.) Karl Zickler. Describing the author's experiments in telegraphing by the use of the ultra-violet waves of light, which, when projected upon a suitable receiver produce electrical discharges in an induction-coil circuit. Two articles, 4500 w. Elektrotech Zeitschr—July 14, 21, 1898. No. 22364 each B.

Long-Distance.

Connector for Long-Distance Telephone. (Neue Schaltung für der Sprechverkehr auf Grosse Entfernung.) M. Schwensky. An improved switch connector is used to cut out alternately the receiver or transmitter, with the result of greatly improving the distinctness. Successful tests have been made over distances of 1800 miles. 1200 w. Elektrotech Zeitschr—July 28, 1898. No. 22368 B.

Party Lines.

Party Lines. Kempster B. Miller. Discussion of this problem. Part first explains the term as applied to telephone work, and gives illustrated descriptions of some of the systems in use. 2300 w. Elec Engng—Aug., 1898. No. 22183.

Report.

Report from the Select Committee on Telephones. Authorized text of the report of committee appointed to consider questions relating to the municipalization of the telephone service in England, with editorial. 7500 w. Elect'n, Lond—Aug. 19, 1898. No. 22174 A.

Space Telegraphy.

Ducretet on Hertzian Telegraphy. Calls attention to some statements made by Ducretet in a lecture before the Société Internationale des Electriciens, and describes a new arrangement of apparatus for automatically printing messages in the Morse code. Ill. 1200 w. Elec Rev, Lond—Aug. 12, 1898. No. 22171 A.

Improvements Relating to Electric Telegraphy. Particulars from the specification of Lodge and Muirhead's patent for telegraphing by means of Hertzian waves. The invention has for its objects to provide means of obtaining greater certainty of action and an increase of distance. 1000 w. Elec Rev, Lond—Aug. 12, 1898. No. 22172 A.

Lodge's System of Syntonized Wireless Telegraphy. A detailed description of this system with illustrations. 2500 w. Elec Rev, Lond—Aug. 19, 1898. No. 22420 A.

Obstruction of Hertz Waves by a Metallic Envelope. (Une Enveloppe Métallique ne se Laisse pas Traverser par les Oscillations Hertziennes.) A note by M. Branly, showing how the emission or reception of Hertz waves may be controlled by metallic envelopes; a valuable feature in connection with space telegraphy. 1000 w. Comptes Rendus—July 4, 1898. No. 22344 D.

Telegraph Property.

Submarine Telegraph Property. Some account of the past year's working of the Globe Telegraph and Trust Co., Limited. 600 w. Engng—Aug. 12, 1898. No. 22159 A.

Telegraph Work.

The Effect of Telegraph Work on the Health. From the *Lancet*, London. Extract from address of J. T. Hull, president of the Ry. Telegraph Clerks' Assn., claiming very deleterious effects. 400 w. Elec Rev, N. Y.—Aug. 24, 1898. No. 22204.

Timing Calls.

Timing Calls in Telephone Exchanges. Henry Abbott. Considers the relative merits of the different methods and appliances employed in timing calls in telephone exchanges in the United States. Showing the adaptability of the calculagraph for telephone service. Ill. 5800 w. Elec Eng, N. Y.—Aug. 25, 1898. No. 22207.

MISCELLANY.

Conductivity Method.

The Reliability of the Dissociation-Values Determined by Electrical Conductivity Measurements. Arthur A. Noyes. A criticism of an article by von Laar, in *Ztschr. phys. Chem.*, claiming that the dissociation values calculated from electrical conductivity are incorrect, and showing that his "proofs" are not reliable. 2500 w. Tech Quar—June, 1898. No. 21818 F.

Exposition.

Department of Electricity at the Trans-Mississippi and International Exposition. Illustrates and describes the building and exhibits. 1800 w. W Elect'n—Aug. 27, 1898. No. 22258.

Galvanometers.

On the Best Resistance for a Sensitive Galvanometer. Frank A. Laws. A statement of the usual solution of the problem of obtaining the proper adjustment of the galvanometer resistance to the work in hand, and deriving a solution under conditions other than those usually imposed. 1200 w. Tech Quar—June, 1898. No. 21820 F.

Induction.

Note on the Simplification of the Law of Induction. (Bemerkungen zur Fassung des Induktionsgesetzes.) Max Breslauer. A discussion of the existing laws of electrical induction showing how they can be simplified and condensed into one comprehensive law. 1800 w. Elektrotech Zeitschr—July 28, 1898. No. 22367 B.

Phaseometer.

A Direct Indicating Phaseometer (Ueber einen Direkt Zeigenden Phasenmesser.) Th. Bruger. Describing the Hartmann & Braun apparatus, which resembles a double watt-meter, with two movable bobbins. An illustration of the instrument and diagrams of the windings are given. 1500 w. Elektrotech Zeitschr—July 14, 1898. No. 22365 B.

Radiography.

Improved Radiographic Apparatus. From *Illustrirte Zeitung*. Illustrated description of improved apparatus, with brief reference to the applications now in use. 1300 w. Sci Am Sup—Aug. 20, 1898. No. 22115.

Resistance.

Electric Resistance upon the Contact of Two Disks of the Same Metal. (Résistance Electrique au Contact de Deux Disques d'un Même Métal.) E. Branly. A detailed account of numerous experiments with disks of various metals. 1000 w. Comptes Rendus—July 25, 1898. No. 22347 D

Our Knowledge of the Value of a Resistance. W. E. Ayrton. From the London *Electrician*. On the degree of accuracy with which the resistance of a conductor can be stated in absolute measure. 2000 w. Sci Am Sup—Aug. 27, 1898. No. 22237.

Rules.

Safety Regulations for Electric Installations. (Sicherheitsvorschriften für Elektrische Starkstromanlagen.) A full reprint of the rules adopted by the German Society of Electricians at the Frankfort Convention of 1898. Two articles. 9000 w. Elektrotech Zeitschr—July 21, 1898. No. 22366 each B.

X-Rays.

Cathode Jets. C. E. S. Phillips. An account of experiments made and facts observed. Ill. 700 w. Elect'n, Lond—July 22, 1898. No. 21865 A.

The Decreasing Demand for X-Ray Apparatus. W. J. Clarke. Thinks the reasons are explained by the high price, the apparatus being too complicated, and often difficult to handle. 900 w. Elec Eng, N. Y.—Aug. 11, 1898. No. 22016.

Zeeman Effect.

New Observations upon the Zeeman Effect. (Observations Nouvelles sur le Phénomène de Zeeman.) MM. Becquerel and Deslandres. Giving the results obtained by the use of a Rowland grating and a very intense magnetic field. 3000 w. Comptes Rendus—July 4, 1898. No. 22343 D.

MARINE ENGINEERING.

Bulkhead Doors.

The Cowles System of Water-Tight Bulkhead Doors for the U. S. Cruiser "Chicago." The two methods of central control, known as the "double line" and the "single line" systems, are described; the latter being the one employed on the "Chicago." Ill. 1200 w. Eng News—Aug. 18, 1898. No. 22121.

Collisions.

Is There Any Excuse for Collisions at Sea? Hermann Herberts. A letter explaining means for detecting the presence of a vessel or iceberg, and how their movements may be followed. 3200 w. Sci Am Sup—Aug. 6, 1898. No. 21933.

Space Telegraphy and Collisions at Sea. (Télégraphie sans Vil et Collisions en Mer.) A note by M. Branly in connection with the suggestion of MM. Berget and Décombe showing how a Hertz exciter and Branly coherer may be used to give warning of approaching ships, and prevent collisions. 1000 w. Comptes Rendus—July 18, 1898. No. 22346 D.

Colomes Stopper.

The Colomés Life and Ship Protector. Illustrates and describes this cellulose plug for closing shot holes, and explains the usefulness of the device. 1700 w. Sci Am—Aug. 20, 1898. No. 22113.

Ferryboats.

Recent Improvements in Mississippi River Ferryboats at St. Louis. William H. Bryan. A statement is given, of the conditions of service required with review of types used in the past, and illustrated description of the latest boats. 3300 w. Marine Engng—Aug., 1898. No. 21973 C.

Governors.

Marine-Engine Governors. (Schiffsmaschinenregler.) A paper by Hr. Dubbel showing the importance of governors for marine engines, with descriptions of some of the more recent forms and discussing the conditions of governing for multiple-expansion engines. 2000 w. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22309 D.

High Pressure.

High Pressure Marine Engines. Editorial on some of the difficulties to be met in using high pressures. 1600 w. Engr, Lond—Aug. 5, 1898. No. 22060 A.

High Speed.

High-Speed Marine Engines. (Schiffsmaschinen mit Hoher Kolbengeschwindigkeit.) A paper by Inspector Eickenradt before the German Society of Mechanical Engineers, discussing especially the methods of counterbalancing in order to diminish vibration at high speeds. Two articles, 4500 w. Glaser's Annalen—July 1, 15, 1898. No. 22359 D.

Launch.

Navigation on African Lakes. C. Du Riche Preller. Brief description of an aluminum launch constructed for the Victoria Nyanza. 400 w. Engng—Aug. 12, 1898. No. 22161 A.

Light House.

Alguada Reef Light-House. Information and description relating to one of the most important light-houses off the coast of Burmah. 1600 w. Ind Engng—July 16, 1898. No. 22139 D.

Merchant Marine.

The Mercantile Shipbuilding of the World. A review of the outputs of the various shipbuilding countries for the last year, with comparison

of previous years, based on statistics from Lloyd's Register. 2000 w. Engs' Gaz—Aug., 1898. No. 21954 A.

Naval Architecture.

Notes on Naval Architecture. Joseph R. Oldhorn. Quotes from paper of Sir Edward J. Reed, and the discussion called out, briefly describes the Japanese battleship "Shikishima"; comments on American warships, &c. Discussion. 6000 w. Jour Ass'n of Engng Soc's—July, 1898. No. 22218 C.

Position Indicator.

Means for Detecting the Presence of a Ship or Iceberg. Hermann Herberts. Outlines methods for study with the view of avoiding collisions at sea. Describes an apparatus consisting of a thermopile and connections. 2700 w. Elec Eng, N. Y.—Aug. 4, 1898. No. 21901.

Propeller.

Screw-Propeller Pattern. I. McKim Chase. Illustrates and describes a method of making a pattern for a screw propeller with separable blades. 2000 w. Mach, N. Y.—Aug., 1898. No. 21889.

Shipping.

The Supply and Waste of Shipping. Editorial comment on the number and tonnage of British vessels removed from active service during 1897, with a comparison of British waste with the rest of the world. Shows a gross decrease of nearly 52,000 tons when compared with 1896. 1300 w. Engng—Aug. 5, 1898. No. 22071 A.

Steam Pipes.

The Use of Copper Steam Pipes. Review of latest British investigations. 600 w. Eng Rec—July 30, 1898. No. 21806.

Steamship.

The Steamship "Kaiser Wilhelm der Grosse." (Le Paquebot "Kaiser Wilhelm der Grosse.") Illustrated description of the great Atlantic liner, with views of the interior, and data about the growth of the North German Lloyd Company. 3500 w. 1 plate. Le Génie Civil—Aug. 6, 1898. No. 22329 D.

The Union S. S. Co.'s Twin-Screw R. M. S. "Briton." An account of a visit to this steamship, with illustrations and description. 700 w. Steamship—Aug., 1898. No. 21958 A.

Twin-Screw Steamer Duke of Cornwall. Illustrated description of the latest vessel added to the fleet in service between England and the North of Ireland. These are all vessels of the highest class, resembling Atlantic liners. 2000 w. Engr, Lond—July 29, 1898. No. 21970 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Bracing.

Boiler-Brace Tests. A. F. Huston. Describes tests and gives points ascertained regarding the strength of rivets. Ill. 1000 w. Power—Aug., 1898. No. 21905.

Economy.

Fuel and Boiler Economy at the Saar Collieries. From a communication by Berginspektor Osterkamp to *Glückauf*. Describes the manner of conducting the steam boilers and the experience gained. 1700 w. Col Guard—July 29, 1898. No. 21967 A.

Efficiency.

Variation in Boiler Efficieny. William D. Ennis. Describes tests recently made by the writer at the electric station of the Consolidated Gas Company of New Jersey, Long Branch, making an attempt to divide the tests into periods for comparison. 1400 w. Power—Aug., 1898. No. 21904.

Explosions.

Accidents to Steam Boilers during 1896. (Accidents d'Appareils à Vapeur en 1896.) The official report of accidents to steam apparatus, in tabulated form, with plates of illustrations showing the nature of the explosions. 6000 w. 3 plates. Ann des Ponts et Chaussées—1 trimestre, 1898. No. 22340 F+G.

The Buffalo Boiler Explosion. E. E. Williams. Illustrated description of the explosion at the Niagara factory of the National Starch Mfg. Co. at Buffalo, N. Y., where 7 were killed and 21 injured. 1000 w. Sci Mach—Aug. 1, 1898. No. 21825.

Fallacies.

Fallacies Concerning Boilers. Editorial discussing a few of these. 1800 w. Engr, Lond—Aug. 12, 1898. No. 22069 A.

Fan Blowers.

The Design of Fan Blowers. Walter B. Snow. A discussion of fan blowers and the theoretical considerations which govern their design. 3000 w. Mach, N. Y.—Aug., 1898. No. 21888.

Feed-Water

Water-Softening and Purification by the Archbutt-Deeley process. Leonard Archbutt. Read before the British Inst. of Mech. Engs. An explanation of the process and the chemical changes; also referring to other processes and to points bearing upon the formation of boiler scale. 5500 w. Col Guard—Aug. 12, 1898. No. 22166 A.

Fuel.

Gas Coke for Generator Fuel. C. M. Converse. Read before the Pacific Coast Gas Assn. Relates the difficulties met in learning how to use this fuel, and how they were overcome. Discussion. 3800 w. Am Gas Lgt Jour—Aug. 22, 1898. No. 22199.

See Mining and Metallurgy, Miscellany.

Gauges.

How to Read Gauges. Alfred Siebert. Con-

siders pressure gauges, glass gauges, the oil receiver, and the liquid receiver, and how trouble was located. 2200 w. Ice & Refrig—Aug., 1898. No. 21827 C.

Grates.

The Relation of Air Space in Grates to Boiler Economy. Editorial discussion of influence of variations in air space as shown by tests. 800 w. Eng Rec—July 30, 1898. No. 21804.

Hardening.

Continuous Hardening Furnace. An illustrated description of a furnace designed for hardening bicycle balls, but applied also to other work. 700 w. Engng—Aug. 19, 1898. No. 22291 A.

Plate Welding.

Boiler-Plate Welding. W. D. Wansbrough. From *The Boilermaker*. Explains the restrictions placed on the use of welded boiler seams in England, stating their advantages, and gives practical directions for welding the longitudinal seams of a boiler flue or cross tube. Ill. 4300 w. Mech Wld—Aug. 12, 1898. No. 22152 A.

Powdered Coal.

New Coal-dust Furnaces. Describes and illustrates recent devices, differing somewhat from those hitherto proposed. Considers the Pinther system; the Kussell, Lester and Ernst systems; the Peck and Patterson systems, and the Juckes furnace. 1400 w. Ir & Coal Trds Rev—July 29, 1898. No. 21965 A.

Scale.

Mineral Oils as Scale Preventives. Information concerning the nature and action, and the best way of using, petroleum derivatives. 1900 w. Locomotive—July, 1898. No. 22097.

Smoke Prevention.

The Hinstin Smoke-Consuming Furnace. From *La Revue Technique*. Illustrated description. 600 w. Col Guard—July 22, 1898. No. 21833 A.

The Suppression of the Production of Smoke by Boiler Furnaces. (Suppression des Fumées Produites par les Foyers des Chaudières à Vapeur.) A. Boyer-Guillon. A condensation of the report of the Paris Smoke-Prevention Commission with illustrations of the apparatus and of the successful furnaces in the competition. two articles. 6000 w. Le Génie Civil—July 16, 23, 1898. No. 22325 each D.

Specifications.

Boiler-Steel Specifications. A collection of figures selected from specifications under which a large quantity of boiler steel is being purchased for both locomotive and stationary boilers, with comments and editorial. 2000 w. Ry & Engng Rev—Aug. 27, 1898. No. 22281.

Steam.

Making Steam in Boilers. A comparison of the water-tube and tank systems. 1000 w. Bos Jour of Com—Aug. 20, 1898. No. 22186.

Superheating.

The Schmidt Superheating System. Translated from *Portefeuille Economique des Machines*. Illustrates and describes a construction that ensures perfect circulation of the firebox gases, thus avoiding troubles from burned tubes, separated joints, leakage, &c. 1400 w. Mech Wld—July 29, 1898. No. 21955 A.

Tests.

Tests of Boilers, Engines, Elevators, and Ventilating Plant, Chicago Public Library. Interesting portions of the report of George H. Barrus, who was retained by the board of directors to make a complete test. An important article, showing results that led to many improvements. Ill. 3500 w. Eng Rec—Aug. 6, 1898. No. 21989.

Water-Tube.

The Miyabara Water-Tube Boiler. Illustrates and describes a water-tube boiler designed by the constructor officer of the Imperial Japanese Navy. 700 w. Engr, Lond—Aug. 19, 1898. No. 22404 A.

Water-Tube Boilers (Wasserröhrenkessel.) A paper by Hr. Ulrici, reviewing the subject generally and giving special information concerning the Steinmüller boiler with data and results of tests. 1500 w. Zeitschr d Ver Deutscher Ing—July 16, 1898. No. 22306 D.

COMPRESSED AIR.

Compressor.

The Strnad Air Compressor at the Maybach Mine. (Luftkompressionsmaschine System "Strnad" auf Grube Maybach.) Illustrated description of double-cylinder tandem air compressor, with Corliss valves on air cylinders. Full details are given, together with indicator diagrams. 2000 w. 1 plate. Glückauf—July 30, 1898. No. 22353 B.

Mine Locomotive.

The Compressed-Air Mine Locomotive. Part first gives a brief statement of the advantages urged by those in favor of compressed-air haulage, and describes various types of locomotives used. Ill. 2800 w. Ir & Coal Trds Rev—Aug. 5, 1898. Serial. 1st part. No. 22057 A.

Pneumatic Tubes.

Recent Progress in the Development of Pneumatic Dispatch Tubes. B. C. Batcheller. Brief reference is made to European systems, showing progress to 1893; an account of the 6-inch tubes put into operation in Philadelphia, and the 8-inch tubes in New York, with an explanation of the theory. Ill. 6500 w. Jour Fr Inst—Aug., 1898. No. 21910 D.

Sand Blast.

The Sand-Blast Process as Applied to the Cleaning of the Walls of Pardee Hall, Lafayette College. J. C. Heckman. Illustrates and describes the application of the sand blast to the cleaning of stone walls from smoke stains after a fire. 1100 w. Compressed Air—Aug., 1898. No. 21914.

Science.

Recent Science. Prince Kropotkin. Parts first and second deal with the progress made in liquefying air and gases; parts third and fourth, with motive power and transmission. 9800 w. Nineteenth Cent—Aug., 1898. No. 22020 D.

Tests.

Tests of a King-Reidler Air Compressor at the Rose Deep Mine, South Africa. L. I. Seymour. Read before the South African Assn. of Engs. and Arch'ts. Data of tests made, with summary of results and explanatory remarks. 1500 w. Compressed Air—Aug., 1898. No. 21915.

ENGINES AND MOTORS.

Blowing Engines.

Blowing Engines. James Proctor. Read before the South Staffordshire Inst. of Iron and Steel-Works Managers. Deals only with blowing engines as connected with blast furnaces. Ill. 2500 w. Engr, Lond—Aug. 5, 1898. No. 22062 A.

Breakdowns.

Mill Engine Breakdowns. Items of interest from the chief engineer's report to the Engine, Boiler and Employers' Liability Insurance Company, Limited, describing causes of breakdowns in steam and gas engines, &c. Ill. 1600 w. Mech Wld—Aug. 19, 1898. No. 22286 A.

Compound Engine.

Compound Engine 1500 Horse Power. (Verbunddampfmaschine von 1500 P S.) A short description of this handsome vertical engine with photograph and plate of detailed drawings. 500 w. 2 plates. Zeitschr d Ver Deutscher Ing—July 16, 1898. No. 22305 D.

The 1500-Hp. Engines for the Berlin, Germany, Electric Works. From the *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrated description of the cross-compound engines built for this company which operates the five central lighting stations of Berlin. 600 w. Eng News—Aug. 25, 1898. No. 22226.

Cylinders.

Cylinders for Compound Engines. Tables for computing the sizes of cylinders for compound engines arranged for both condensing and non-condensing, with boiler pressures varying by increments of 10 lbs. from 80 to 250 lbs. per square inch above the atmosphere. 600 w. Mech Wld—July 29, 1898. No. 21956 A.

Diesel.

The Diesel Heat Engine. Illustrated description of the engine and its operations. 1300 w. Am Eng & R R Jour—Aug., 1898. No. 21878 C.

Engines.

Westinghouse Steam and Gas Engines and Generators. An account of a visit made to inspect some of the new engines and electrical apparatus about to be shipped to England. 800 w. R R Gaz—Aug. 5, 1898. No. 21926.

Engine Shafts.

The Evolution of the Modern Engine Shaft. H. F. J. Porter. Gives the history of the development and processes for making steel shafts. Ill. 5000 w. Power—Aug., 1898. No. 21906.

Gas Engines.

Some Notes on the Modern Commercial Gas Engine. Carmichael Peebles. Read at meeting of the North British Assn. of Gas Managers. Gives briefly the history of the Otto cycle gas engine, the changes since first brought out, improvements in details, &c. 4500 w. Gas Wld—July 30, 1898. No. 22013 A.

Tests of an 100-H.P. Otto-Crossley Gas-Engine. Abstract of the graduating thesis of E. H. Brown of the Worcester Polytechnic Inst. Description of the plant and tests with conclusions. 1700 w. R R Gaz—Aug. 26, 1898. No. 22250.

Governors.

The Design and Setting of Shaft Governors. J. C. Cornock. Part first discusses the prevention of internal friction, the arrangement of the spring, &c. Ill. 1400 w. Mech Wld—Aug. 12, 1898. Serial. 1st part. No. 22151 A.

Heat Motor.

The High-Pressure Heat Motor. (Der Hochdruckwärme Motor.) A paper by J. Lüders discussing the increase of working pressure in internal-combustion motors, with especial reference to the thermodynamics of the Diesel motor. 6000 w. Zeitschr d Ver Deutscher Ing—July 9, 1898. No. 22302 D.

Indicator.

Remarks on the Steam-Engine Indicator. W. S. Bailey. Read at a meeting of Inst. of Engs. and Shipbuilders at Hong Kong. History of the invention and improvement in details, the manner of use, the diagrams, and general usefulness. 5500 w. Steamship—Aug., 1898. No. 21959 A.

Indicator Cards.

The Point of Cut-Off. Editorial on proper location of this point on the card and its importance. 700 w. Eng Rec—Aug. 27, 1898. No. 22269.

Steam Engine.

Horizontal Tandem-Compound Steam Engine. Illustrated description of an engine possessing many features of interest, special devices for obtaining steady running at a pre-determined speed, with a minimum of attention. 2700 w. Prac Eng—Aug. 12, 1898. No. 22175 A.

Vacuum.

High Vacuum in Condensing Engines. Editorial discussion concluding that in an engine which has tight valves and pistons, and is provided with condensing apparatus and air pump suitably designed for the work, the higher the vacuum the better will be the economy. 700 w. Eng Rec—Aug. 6, 1898. No. 21985.

Valve Gear.

Corliss Valve Gear. Editorial on the difficulties standing in the way of the production of a positive Corliss gear. 1500 w. Engr, Lond—Aug. 19, 1898. No. 22408 A.

Winding Engines.

Powerful Winding Engines at the Preussen Colliery, Westphalia. E. Tomson. From a communication to the jubilee meeting of the

Liége Engs.' Assn. Side elevation, plan and dimensions, with description of the arrangement adopted and statement of its advantages. 3200 w. Col Guard—July 22, 1898. No. 21831 A.

POWER AND TRANSMISSION.

Dynamometer.

Some New Forms of Transmission Dynamometer. John J. Flather. Illustrated description of a type of dynamometer which has given satisfaction under a variety of conditions in the laboratory and shop. 1200 w. Mach, N. Y.—Aug., 1898. No. 21886.

Gravity System.

The Holly Gravity Return System. Illustrates and describes the recent installation in the Twenty-sixth St. power station of the Edison Electric Illuminating Co., of New York. 1700 w. Sci Am—Aug. 20, 1898. No. 22112.

Power Cost.

The Comparative Cost of Steam and Water Power. William O. Webber. A comparison based upon the most recent data, showing the various items in detail and the great reductions in the cost of power both for steam and water. 3000 w. Engineering Magazine—September, 1898. No. 22383 B.

Power Gas.

Power from Producer Gas. W. H. Booth. Describes the new gas plant installed by Mr. Arthur Parritt, at Birstal, in Yorkshire, commenting on the advantages. 2300 w. Am Mach—Aug. 4, 1898. No. 21935.

The Direct Utilization of Blast-Furnace Gases. (Utilisation Directe de Gaz des Hauts Fourneaux.) Aug. Dutreux. A general review of the results thus far attained at Seraing and elsewhere, with excellent photographs of motors of 150 to 250 h. p. for use with furnace gases. Two articles. 4500 w. Le Génie Civil—July 23, 30, 1898. No. 22326 each D.

Power Measuring.

Electric Motors for Measuring Power in Place of Transmission Dynamometers. E. B. Raymond. Extract from discussion at meeting of the New England Cotton Mfrs. Assn. Also extract from discussion by Calvert Townley. Describes methods. 2300 w. Power—Aug., 1898. No. 21907.

Water Power.

Water-Power Development by the Lake Superior Power Co., at St. Mary's Falls, Mich. Describes the plant of this company on the American side of the river, at Sault Ste. Marie, Mich., which is to be completed in two years. Ill. 3300 w. Eng News—Aug. 4, 1898. No. 21941.

SHOP AND FOUNDRY.

Arc Works.

The New Arc Works at Chelmsford. Illustrates and describes the new works of Messrs. Crompton & Co. for the manufacture of high-class electrical plant. 3700 w. Elec Eng, Lond—Aug. 5, 1898. No. 22054 A.

Brass.

The Influence of Bismuth on Brass, and its Relation to Fire-Cracks. Erwin S. Sperry. Describes experiments made while investigating this subject giving results and conclusions. Ill. 1800 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22265 D.

Brazing.

Electrical Shop Work. B. F. Fells. Brief illustrated description of the best methods of setting up and using a brazing outfit. 900 w. Elec Wld—Aug. 13, 1898. No. 22017.

Cranes.

Electric Cranes. (Elektrisch Betriebene Krane.) Chr. Eberle. Many details of electric traveling cranes, with a plate of single-motor crane of 12-tons capacity, and illustrations of a 65-ton Oerlikon crane. 5000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22307 D.

Cupola Practice.

Modern Cupola Practice, with Special Reference to the Discussion of the Physics of Cast-Iron. Bertrand S. Summers. Outlines the effects of the metalloids, mentions some new ideas which recent practice has developed, giving some results of practical tests. 7000 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22260 D.

Ellipsograph.

The Mundo Ellipsograph. Morris Fulton. A sketch and brief description of the ellipsograph made and used at the Mundo Iron Works, and found convenient by the draftsmen. 1600 w. Am Mach—Aug. 11, 1898. No. 22026.

Files.

The Manufacture of Files. (Die Herstellung der Feile.) Illustrated account of the process of file making, including both hand and machine cutting, with illustrations of German file-cutting machines. 3000 w. Stahl und Eisen—Aug. 1, 1898. No. 22358 D.

Forging.

The Forging and other Presses at the Kalk Machine Works. (Schmiede und Andere Pressen der Kalker Werkzeugmaschinenfabrik.) A paper by Herr Meune with valuable data and indicator diagrams showing the action of hydraulic forging presses performing given operations. 3000 w. Zeitschr d Ver Deutschr Ing—August 6, 1898. No. 22315 D.

Foundry Conditions.

Foundry Conditions Abroad. Martin Fox. Some general impressions of the conditions of molders and of the British foundry trade. 1200 w. Ir Trd Rev—Aug. 25, 1898. No. 22243.

Guides.

Lining Guides. Ira A. Moore. Describes how the work should be done. Ill. 1600 w. Loc Engng—Aug., 1898. No. 21884 C.

Hinge-Bolts.

The Use of Hinge Bolts on Movable Covers. (Boulons à Charnière des Obturateurs Amovibles.) MM. Polonceau and Walckenaer. Re-

viewing a large number of accidents which have occurred from the use of hinged bolts to secure covers upon vessels containing steam under pressure. Illustrations of many cases are given. 10000 w. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22339 F+G.

Index-Plates.

Making Original Index Plates. William Baxter, Jr. Illustrated description of two methods devised by the writer. 1000 w. Am Mach—Aug. 4, 1898. No. 21937.

Lathes.

A Shafting Lathe. Describes a lathe having some new features, which is intended both for general lathe work and for turning shafting, and arranged so as to be quickly changed from one kind of work to the other. Ill. 700 w. Am Mach—Aug. 18, 1898. No. 22118.

A Steady-Pin Lathe. A. H. Cleaves. Illustrates and describes a special tool used by watch makers, but also useful for other work. 700 w. Am Mach—Aug. 11, 1898. No. 22025.

Piper.

Pipes and Fittings. Tecumseh Swift. Calls attention to some particulars needing improvement, offering suggestions. 1200 w. Am Mach—Aug. 11, 1898. No. 22027.

Rack.

Originating the Hoe Rack. John Randol. Illustrates and describes the making of a machine requiring great accuracy. 4000 w. Am Mach—Aug. 18, 1898. No. 22119.

Riveting.

Systems of Riveting for Boiler Construction. (Entwerfen von Dampfkesselnietungen.) H. Dieckhoff. A mathematical investigation, comparing the rules of the City of Hamburg, the German Lloyds, the Bureau Veritas, and the Lloyds Register with diagrams of many arrangements showing the percentage of full strength obtained. 3000 w. Zeitschr d Ver Deutscher Ing—August 6, 1898. No. 22314 D.

Steam Pipes.

See Marine Engineering.

MISCELLANY.

Aerodynamics.

The Aerodynamics of a Thin Plate, and the Conditions of its Descent. (Der Aerodynamische Schwedzustand einer Dünnen Platte und deren Sinkgeschwindingkeit.) F. R. v. Loessl. A mathematical investigation with diagrams of experiments, furnishing valuable data in connection with aerodynamical problems. Three articles. 10000 w. Zeitschr d Oesterr Ing u Arch Ver—July 29, Aug. 5, 12, 1898. No. 22322 each B.

Aeronautics.

The "Avion." From *L'Illustration*. Illustrated description of an apparatus devised and constructed by M. Ader, a French engineer. 1500 w. Sci Am—Aug. 27, 1898. No. 22235.

Automobiles.

Electric Carriages. J. T. Niblett. Gives some recent improvements in accumulators and their application to traction on common roads. 2500 w. Elec Rev, N. Y.—Aug. 17, 1898. No. 22099.

French Tests of Electric Cabs for City Service. Reports an interesting and valuable test of electric cabs, carried out in Paris. Eleven carriages were entered. Ill. 1000 w. Elec Eng, N. Y.—Aug. 4, 1898. No. 21903.

The "American" Electric-Motor Vehicles. Illustrates and describes some of these vehicles. 1300 w. Elec Eng, N. Y.—Aug. 18, 1898. No. 22104.

The Automobile Race between Paris and Amsterdam. (La Course d'Automobiles Paris-Amsterdam-Paris.) A general description of this important road competition with numerous photographs of the competing machines. Serial. 1st part. 4000 w. La Revue Technique—July 25, 1898. No. 22331 D.

The "Cyclope" Petroleum-Spirit Motor. General view, detail drawings and description. 1000 w. Ind & Ir—Aug. 19, 1898. No. 22411 A.

The Doré Electrical Motor-Cab. Brief illustrated description. 600 w. Ind & Ir—Aug. 19, 1898. No. 22412 A.

The Landry-Beyroux Motor Carriage. Illustrated description of a motor carriage at the recent Paris exhibition which presents several novel features. 800 w. Ind & Ir—Aug. 12, 1898. No. 22167 A.

Toward's Steam Tractor. Illustrated description of a steam tractomotor built at Newcastle-on-Tyne. 700 w. Engr, Lond—Aug. 19, 1898. No. 22407 A.

Balancing.

An Instructive Mechanical Failure. Wilfred Lewis. Illustrated discussion of an alleged improvement in balancing a locomotive driving-wheel. 4500 w. Jour Fr Inst—Aug., 1898. No. 21911 D.

Bicycles.

The Efficiency of Bicycles. R. C. Carpenter. Part first explains the meaning of the term "efficiency" as used, and discusses the efficiency of bearings and of driving mechanism, giving diagrams. 2500 w. Engng—Aug. 19, 1898. Serial. 1st part. No. 22294 A.

The Increasing Weight of the Bicycle. Editorial comment on the increase in weight of American wheels, considering it a distinctly retrograde step. 1400 w. Sci Am—Aug. 27, 1898. No. 22232.

Combing.

Combing Machines. Illustrated description of an interesting improvement in this class of machinery. 900 w. Bos Jour of Com—Aug. 20, 1898. No. 22187.

Composition of Water.

James Watt and the Discovery of the Composition of Water. T. E. Thorpe. The Watt Memorial Lecture, delivered in the Watt Memorial Hall, Greenock. From *Nature*. A statement of the essential facts that led to the recognition of the true chemical nature of water. 7000 w. Sci Am Sup—Aug. 6, 1898. No. 21932.

Crank Pins.

Stresses in Crank Pins and Axles. Explaining the stresses at work to produce rupture. 1000 w. Loc Engng—Aug., 1898. No. 21885 C.

Hoisting.

The Brown Hoisting and Conveying Machinery. (Die Brownschen Hebe- und Fördervonichtingen.) Axel Sahlin. A paper before the Eisenhüttenleute, describing this well-known American system of conveying materials. 3500 w. Zeitschr d Ver Deutscher Ing—July 9, 1898. No. 22300 D.

Inertia.

A New Inertia Indicator. Wilfred Lewis. Read before the Engs'. Club of Phila. Describes the instrument and illustrates its application. 900 w. Ir Age—Aug. 4, 1898. No. 21908.

Loading.

Some Modern Methods of Loading Coal. Illustrates and describes the Werner system and the Wellman-Seaver system. 1200 w. Ir & Coal Trds Rev—July 29, 1898. No. 21964 A.

Museum.

The Centenary of the Conservatoire des Arts et Métiers. (Le Centenaire du Conservatoire des Arts et Métiers.) A historical account of this famous French mechanical museum and educational institution, with illustrations of various portions of the buildings. 1500 w. Le Génie Civil—July 16, 1898. No. 22324 D.

Pantagraph.

A New Pantagraph. A. H. Cleaves. A description of the machine with illustrations; also a note from the inventor regarding the principles upon which the machine is based. 800 w. Am Mach—Aug. 4, 1898. No. 21936.

Pump.

See Electrical Engineering, Power.

Refrigeration.

Carbonic-Acid Refrigerating Machines. (Les Machines Frigorifiques à Acide Carbonique). P. de Mériel. An illustrated description of the Escher, Wyss & Co. refrigerating machines, operating with carbonic-acid gas, and extensively used in the French breweries. 2000 w. La Revue Technique—July 25, 1898. No. 22329 D.

Recent Improvements in Refrigerating Machinery. (Neuerungen und Fortschritte auf dem Gebiete der Kälteerzeugung.) Prof. H. Lorenz. With especial reference to improvements in compressors and valves, with many detailed illustrations. 4500 w. Zeitschr d Ver Deutscher Ing—July 30, 1898. No. 22311 D.

Refrigeration and Thermodynamics. J. E. Johnson, Jr. Part first discusses the relation between science and practice, steam engineering, refrigeration and thermodynamics, &c. 3000 w. Ice & Refrig—Aug., 1898. Serial. 1st part. No. 21826 C.

Shop Costs.

Effective Methods of Finding and Keeping Shop Costs. Henry Roland. A very full exposition of the system adopted in the works of an extensive electrical-manufacturing company, with forms and details of application. 4500 w. Engineering Magazine—September, 1898. No. 22389 B.

Spiral.

The Hyperbolic Spiral. Walter K. Palmer. A description of the properties of the hyperbolic spiral, showing its use in connection with the drawing board for the solution of geometrical and trigonometrical problems. 3000 w. Kan Univ Qr—July, 1898. No. 22216 D.

Thermodynamics.

Heat Diagrams and Cycles of Gases. (Das Wärmediagramm des Gase und deren Kresprozesse.) Ugo Ancona. A mathematical discussion of the entropy diagram, with an examination of special cases. 3000 w. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22308 D.

Thermometry.

Recent Work in Thermometry. C. Chree. A brief account of recent progress. 5000 w. Nature—July 28, 1898. No. 21957 A.

Tyres.

Pneumatic v. Iron Tyres. From a paper read before the Société des Ingénieurs Civil, by M. Michelin, giving the results of some experiments made to determine the relative qualities of pneumatic and iron tyres. 400 w. Prac Eng—July 29, 1898. No. 22014 A.

Valves.

A Quick-Acting Valve Gear. Describes an invention of A. Long, possessing qualities worth examining. Ill. 500 w. Bos Jour of Com—Aug. 6, 1898. No. 21999.

MILITARY ENGINEERING.

Armor Plate.

Test of a Six-Inch Experimental Krupp Plate. Illustrates and describes the tests at the Indian Head Proving Ground, reporting the results. The plate was made by the Carnegie Company. 1500 w. Sci Am—Aug. 27, 1898. No. 22234.

The Carnegie Krupp Armor Plate. W. L. C. Reports the test of the first armor plate made in this country under the Krupp process, the results being most gratifying. Ill. 700 w. Ir Age—Aug. 18, 1898. No. 22107.

Battleships.

Alabama Class Battleships. Illustrated description of the Alabama, Illinois and Wisconsin, sister ships, soon to be added to the U. S. navy. 1600 w. Marine Rev—Aug. 11, 1898. No. 22030.

Battleships Kearsarge and Kentucky. An interesting illustrated description of these two vessels nearing completion, with their equipment. 3 plates. 5500 w. Marine Rev—Aug. 11, 1898. No. 22028.

Higher Speed for Our New Battleships. Edi-

torial on the necessity of future battleships being vessels of large coal endurance and high speed. 1400 w. Sci Am—Aug. 6, 1898. No. 21916.

In the Engine Room of the Texas. Kenneth McAlpine. From the *N. Y. Evening Sun.* Interesting description of the work in the engine-room during the engagement with Cervera's fleet. 1600 w. Am Mach—Aug. 25, 1898. No. 22225.

The Performance of the "Oregon's" Engines on Their Great Run of 15000 Knots. A letter from C. N. Offley, published in the *N. Y. Sun.* An interesting account of the trip. 2300 w. Sci Am Sup—Aug. 27, 1898. No. 22239.

The "Texas" in Action. Reviews briefly the history of this warship, with illustrated description of the damage wrought by Spanish shells during the Santiago engagement. 1800 w. Sci Am—Aug. 20, 1898. No. 22114.

The Work of the Battleship Oregon. An account of the remarkable trip from the Pacific Coast and the performance after joining the fleet and during the battle at Santiago, with list of officers. 2800 w. Am Mach—Aug. 25, 1898. No. 22224.

Cervera's Fleet.

The Battle with Cervera's Fleet Off Santiago. Winston Churchill. Compares the training for the navy in America and Spain; the race differences; the ships; giving incidents of the battle and pictures of brave deeds. Ill. 7800 w. Am Rev of Revs—Aug., 1898. No. 21868 C.

Cruisers.

Ships of the Armored-Cruiser Type. An account of the work done by this type of vessel in the naval engagement at Santigo, showing their efficiency, and referring to the probability of others being constructed for the U. S. navy. 1600 w. Marine Rev—Aug. 11, 1898. No. 22031.

Finances.

Cost and Finances of the Spanish War. Charles A. Conant. Reviews appropriations made by Congress, discussing the actual cost, contingent expenses, the popular loan, etc. 5500 w. Am Rev of Revs—Sept., 1898. No. 22279 C.

Floating Hospitals.

Our Ambulance Ships. Illustrates and describes the "Solace" and "Relief," of the U. S. navy, and their equipment for hospital service. 2000 w. Marine Rev—Aug. 11, 1898. No. 22029.

Floating Shop.

U. S. S. Vulcan, a Floating Machine Shop. Description from a lecture at the Naval War College, by W. M. McFarland; also brief descriptions of repair ships of other nations. 2800 w. Am Mach—Aug. 18, 1898. No. 22117.

Gun-Fire.

Gun-Fire Analysis of the Santiago Sea Fight. The gun-fire analyzed for the Santiago sea fight by Lieut. B. W. Wells, with some of the causes to which the victory was due. 600 w. Eng News—Aug. 18, 1898. No. 22123.

Guns.

The Guns of Our Navy. Henry Hess. Information of interest. 800 w. Mach, N. Y.—Aug., 1898. No. 21887.

Man-of-War.

A War-Ship Community. W. J. Henderson. Illustrated description of life on a man-of-war. 4200 w. Scribner's Mag—Sept., 1898. No. 22176 C.

Monitor.

Ericsson's Coast-Defense Monitor "Nahant." Historical account with illustrated description of the vessel and its operation. 2200 w. Sci Am—Aug. 13, 1898. No. 22048.

Naval Reserve.

Reserves for the Royal Navy. Editorial on the steps being taken in England for strengthening that body. 2200 w. Engng—Aug. 5, 1898. No. 22070 A.

Naval Surgeons.

Naval Surgeons Ashore and Afloat. Francis R. Lee. An account of the efficient organized work of this department of service, the naval hospitals and ships. Ill. 2200 w. Chau—Sept., 1898. No. 22290 C.

Naval Vessels.

A Comparison of British and American Naval Vessels. Taken from the *N. Y. Tribune*, credited to the London *Mail.* An apparently fair and unprejudiced comparison, which concludes that English battleships are better than American, guns much better, projectiles and armor as good, but cruisers much worse. 1200 w. Eng News—Aug. 4, 1898. No. 21945.

Our Latest Naval Vessels. Particulars of the battleships, monitors, torpedo boats and destroyers authorized by congress. 3500 w. Marine Rev—Aug. 11, 1898. No. 22032.

Projectiles.

A Group of Navy Projectiles. Illustrates and describes the shells, of various dimensions, used by the U. S. navy. 800 w. Sci Am—Aug. 6, 1898. No. 21918.

Photographs of Air Waves Formed by Flying Projectiles. An article following in the main, a paper which Colonel von Obermayer contributed to the *Mittheilungen über Gegenstände des Artillerie- und Genie-Wesens.* Describes investigations in this field, giving illustrations. 3000 w. Engng—Aug. 12, 1898. No. 22156 A.

Repeating Pistol.

Borchardt Automatic Repeating Pistol. Illustrated description of the pistol and its action, with report of the trial by United States authorities. 1300 w. Engr, Lond—Aug. 19, 1898. No. 22409 A.

Russian Navy.

Lord Charles Beresford on the Russian Naval Programme. Gives a diagram showing the growth or decrease in numbers of British, French and Russian armor-clads during the last ten years. Calls attention to the increase in the Russian navy, and the prudence of British preparation for maintaining naval supremacy. 1700 w. Engr, Lond—July 29, 1898. No. 21968 A.

Santiago.

The Siege and Capture of Santiago. John A. Church. Gives an account of the transportation of the troops, landing, advance, the attack, and surrender. Ill. 5400 w. Am Rev of Revs—Aug., 1898. No. 21869 C.

Sea Power.

The Essential Elements of Modern Sea Power. Vice-Admiral P. H. Colomb, R. N. A review of the naval programme of England by one of the foremost authorities upon the subject, making important comparisons between England, France and Russia. 4500 w. Engineering Magazine—September, 1898. No. 22380 B.

Smokeless Powder.

An American Smokeless Powder. Frederick H. McGahie. Gives an account of the results obtained by the use of the Maxim-Schupphaus powder, with a brief sketch of the manufacturing process. 2800 w. Sci Am Sup—Aug. 27, 1898. No. 22238.

Squadrons.

Our Eastern Squadron and Its Commodore. Park Benjamin. Some particulars of the squadron under Camara, showing the weakness of the Spanish naval defenses, and also of the squadron the United States was preparing to send east under Watson, with remarks on the personal characteristics of the U. S. Commodore. 4500 w. Am Rev of Revs—Aug., 1898. No. 21870 C.

Torpedo Boats.

Electric Torpedo Boats. Charles T. Child. Brief account of the development of torpedo boats and the tactics prescribed at present for their use, with a statement of the advantages of electrical equipment, because of the absence of smoke, steam and noise, and increased effectiveness. 3000 w. Elec Wld—Aug. 6, 1898. No. 21921.

The Machinery of the New Torpedo Boats and Torpedo-Boat Destroyers. Describes the machinery of the 12 new torpedo boats and 19 torpedo-destroyers as given in the official circular to bidders. 1400 w. Eng News—Aug. 4, 1898. No. 21938.

War Lessons.

Engineering Lessons from the Hispano-American War. Hiram Stevens Maxim. Showing the necessity of the possession of engineering ability to operate modern fighting machinery, and maintaining that mechanical supremacy is the vital factor in military success. 2500 w. Engineering Magazine—September, 1898. No. 22381 B.

MINING AND METALLURGY.

COAL AND COKE.

Ammonia.

Ammonia and Its Sources. Bruno Terne. Discusses the gains from the products of coke-ovens, the system of coking that yields the best results, and other sources of ammonia. 4000 w. Jour Fr Inst—Aug., 1898. No. 21912 D.

See Municipal Engineering, Gas Supply.

Anthracite.

The Anthracite Question. Editorial discussion of the troubles which beset this trade, outlining a plan for the conversion of the coal into gas and its transmission, as the use of gas for domestic purposes is continually increasing. 1400 w. Eng & Min Jour—Aug. 6, 1898. No. 21979.

Arkansas.

The Coal Measures of Arkansas. Charles R. Keyes, in the *Journal of Geology*, Chicago. Facts ascertained recently which make possible a comparison of the enormous thickness of the coal measures of this region, with the more northern districts. 2800 w. Col Guard—Aug. 5, 1898. No. 22066 A.

Carboniferous Rocks.

The Lower Carboniferous Rocks of England and Scotland. William Gunn. From the *Geological Magazine*. The object of the paper is to show the relation of the beds in England and Scotland. 2500 w. Col Guard—Aug. 19, 1898. No. 22400 A.

Coal Cleaning.

Combined Coal Screen and Disintegrator. Illustrates and describes an appliance for cleaning coal by a dry method. 1800 w. Col Guard—Aug. 5, 1898. No. 22065 A.

Coal Seams.

Some Notes on the Bord-and-Pillar System of Work. Attention is called to some details of bord-and-pillar working of importance where economy is needed and commercial success desired. 4400 w. Col Guard—July 29, 1898. Serial. 1st part. No. 21966 A.

Coal Storage.

The West Superior Coal-Storage Plant of the Lehigh Valley Coal Co. William R. Davis. Illustrates and describes a plant having several features of novelty and interest. 1600 w. Eng News—Aug. 18, 1898. No. 22120.

Coke Appliances.

The Automatic Manipulation of Coke. Gilbert Little. Read at meeting of North British Assn. of Gas Managers. Descriptive comments on some of the latest methods of conveying, elevating, screening, sorting and stacking coke. Ill. 1100 w. Gas Wld—Aug. 6, 1898. No. 22076 A.

Coke Industry.

Commercial and Technical Progress of the German Coke Industry. F. Simmersbach. Condensed translation from *Stahl und Eisen*. Information relating to the Ruhr district, the progress made, the ovens used, by products, &c. 2200 w. Am Mfr & Ir Wld—Aug. 12, 1898. No. 22084.

The Recent Development of the German Coke Industry. (Neue Ergebnisse der Deutschen Koksindustrie.) F. Simmersbach. A statistical paper, reviewing the production by districts, from 1890 to 1897, during which period an increase of 55 per cent. occurred. The Otto oven is illustrated and described. 5000 w. Stahl und Eisen—July 15, 1898. No. 22355 D.

Modern Systems of Coking. (Die Heutigen Koksöfensysteme.) A discussion of the various methods of coking with ovens intended to save the by-products; with especial reference to the Neinhaus oven. 4000 w. Glückauf—July 9, 1898. No. 22351 B.

Development of By-Product Coke Making. From advance sheets of the report on the "Manufacture of Coke in 1897," by Edward W. Parker of the U. S. Geological Survey. Discusses the change in methods, the change made in moving the industry from the mining regions to the centers of industrial activity, the use of gas for fuel, and related subjects. 3500 w. Am Mfr & Ir Wld—Aug. 26, 1898. No. 22282.

Deposits.

Indian Coal Deposits. Perry F. Nursey. Articles giving information of the important deposits in India, the methods of working and labor conditions. 2500 w. Ind & Ir—July 29, 1898. Serial. 2 parts. No. 21963 each A.

France.

Results of Recent Borings for Coal in the North of France. (Resultats des Récents Sondages pous la Recherche de la Houille dans le Nord de la France.) J. Gosselet. The results show only coal measures of inferior quality, probably prolongations of the Franco-Belgian basin. 1200 w. Comptes Rendus—July 18, 1898. No. 22345 D.

India.

The Coal Supply of India. Wyndham R. Dunstan. An exhaustive report on the occurrence, distribution, mode of working, production, imports and exports, chemical examination and results. 4500 w. Col Guard—July 22, 1898. No. 21830 A.

Isle of Arran.

The Carboniferous Rocks of the Isle of Arran. From the annual report of the Geological Survey, 1897. Records important new discoveries in the geology of this island in the Firth of Clyde. 4000 w. Col Guard—Aug. 5, 1898. No. 22064 A.

Lignite.

The Calorific Value and Moisture of Lignite. (Heizwert und Wassergehalt der Braunkohlen.) L. C. Wolff. A comparative study of the various German lignites or "brown coals," with computations of the calorific values and tables of the percentages of contained moisture. 5000 w. Zeitschr d Ver Deutscher Ing—July 9, 1898. No. 22301 D.

Royalty.

Colliery Royalty Accounts and Depreciation. George Johnson. Explains the meaning of the term "royalty," and gives an illustration. 2500 w. Col Guard—Aug 12, 1898. No. 22162 A.

Small Mines.

Small Coal Mines. J. T. Beard. How they may be economically worked where the seams are thin and shallow and the field limited. Methods pertaining to their location, and the sinking and timbering of shafts, slopes, drifts, &c., in small operations which do not warrant a large outlay of capital. 4500 w. Mines & Min—Aug., 1898. No. 21947 C.

South Africa.

The Transvaal Coalfield. William Piele. Abstract of paper read before the North of England Inst. of Min. & Mech. Engs. Describes the deposits, quality, and some points relating to the mining. 1500 w. Ir & Coal Trds Rev—Aug. 12, 1898. No. 22168 A.

South America.

The Coal Trade and Lignite Deposits of Northern South America. Francis C. Nicholas. Statements showing what these lignite deposits are and their future possibilities, with brief reference to the future needs of the country and the opportunity for trade. 1800 w. Eng & Min Jour—Aug. 20, 1898. No. 22144.

South Wales.

The Re-Survey of the South Wales Coalfield. A. Strahan. An account of the progress made during the last year by the officers of the Geological Survey in the re-survey of the South Wales coalfield, as given in the annual report. 5500 w. Col Guard—July 22, 1898. No. 21834 A.

COPPER.

Copper Mine.

One of the World's Richest Mines. Some interesting information relating to the Calumet and Hecla mine in northern Michigan. 1200 w. Min & Sci Pr—Aug. 20, 1898. No. 22244.

GOLD AND SILVER.

Alaska.

As Seen by an Old Prospector. "Alex. Quartz." An account of the promising fields near St. Michaels, with some reference to the Klondike, and to other districts. 4500 w. Min & Sci Pr—Aug. 13, 1898. No. 22130.

Arizona.

Notes from Mohave County, Arizona. Theo. B. Comstock. Calling attention to this district as favorable for mining investment, and briefly outlining some of the mining enterprises of the region. 2800 w. Eng & Min Jour—Aug. 6, 1898. No. 21980.

Assay.

The Position of the Assay Department in Mining Economics. Franklin White. The necessity for correct assays and the work of the competent assayer. 1600 w. Jour of Chem & Met Soc of S. Africa—June, 1898. No. 22005 E.

Auriferous Lodes.

The Genesis of Certain Auriferous Lodes. Continued discussion of paper by Dr. John R. Don, presented at the Chicago meeting, Feb., 1897. 1500 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22263 D.

Australia.

Australasian Gold Mining. Dr. Karl Schmeisser. From *Die Goldfelder Australasiens*. Discusses the present and future outlook, drawing favorable conclusions. 1500 w. Aust Min Stand—July 21, 1898. No. 22425 B.

British Columbia.

Lillooet Mining District. W. M. Brewer. An account of this district, the mines being worked, the formation, &c. 2000 w. Eng & Min Jour—Aug. 13, 1898. No. 22088.

Broken Hill.

Some Mining and Metallurgical Developments at Broken Hill. T. J. Greenway. An illustrated account of the mining developments in New South Wales, describing the treatment of the ores. 1800 w. Eng & Min Jour—Aug. 27, 1898. No. 22257.

The Treatment of Broken Hill Sulphide Ores by Wet-Extraction Processes, and the Electrolytic Deposition of Zinc Edgar A. Ashcroft. Abstract of paper read before the British Inst. of Mining & Metallurgy. An account of some novel metallurgical work in Australia which, though a commercial failure, is of interest. 7000 w. Elect'n, Lond—Aug. 19, 1898. No. 22419 A.

Colombia, S. A.

Mining Districts of Colombia. Communications in discussion of the paper by Henry G. Granger and Edward R. Treville. 1800 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22264 D.

Notes on the Mines of the Frontino and Bolivia Company, Colombia, S. A. Spencer Cragoe. Describes the geographical formation and general features of the property, giving an account of mining costs, labor and transport, reduction, &c. 3600 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22262 D.

Concentration.

Advanced Methods of Concentration. J. W. Neill. An extempore address at the Salt Lake session of the International Mining Congress. A discussion of wet concentration, matte smelting, and other processes. 4200 w. Min & Sci Pr—July 30, 1898. No. 21930.

Cripple Creek.

A Trip Around Cripple Creek. Arthur Lakes. Notes on the changes and improvements which have been made there within a short time, with illustrations. 1800 w. Mines & Min—Aug., 1898. No. 21949 C.

Cyanide.

Analyses of Cyanide-Mill Solutions. W. J. Sharwood. Gives analyses made in the laboratory of the Univ. of California, describing methods. 800 w. Eng & Min Jour—Aug. 20, 1898. No. 22142.

Deposits.

The Auriferous Deposits of Siberia. Réné de Batz. Gives some of the reasons for the slow development of these gold fields, describes the general geology of the Siberian placers, the economic conditions, methods of working, &c. Map. 5000 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22266 D.

Dredging.

Hydraulic Dredging. Description, with illustrations, of the working of the Yackandandah leases in Australia, by dredging for gold. 2500 w. Aust Min Stand—June 30, 1898. No. 21880 B.

Kootenay.

A Glimpse at Kootenay and Its Wonders. William Bleasdell Cameron. Illustrates and describes the railroad, scenery, points along the route, the mines, ores, &c. 2000 w. Loc Engng—Aug., 1898. No. 21883 C.

Milling.

Gold Milling. Gilbert E. Bailey. Preliminary work in selecting the processes and machinery suitable for a given ore. Observations on testing plants; classification of processes; sulphurets; ore stamping; situation, construction and arrangement of mills, &c. 3000 w. Mines & Min—Aug., 1898. Serial. 1st part. No. 21952 C.

Nicaragua.

Gold in Nicaragua. C. T. Mixer. Brief account of a region between the 11th and 15th degrees of north latitude, with mention of a few of the properties which have been worked. Ill. 1500 w. Eng & Min Jour—July 30, 1898. No. 21814.

Oregon.

Gold Mining in Oregon. R. W. Barrell. A description of the development of the mines and the peculiarities of the ores and veins of the eastern mining region of the state, together with an account of climate and topography and the methods of working the mines. 5600 w. Mines & Min—Aug., 1898. No. 21950 C.

Prospecting.

Gold Prospecting in New Guinea. John Plummer. Brief account of conditions and the vicissitudes accompanying the work. 700 w. Eng & Min Jour—Aug. 20, 1898. No. 22143.

River Channels.

Gold in Ancient California River Channels. Extracts from the account of the Forest Hill Divide by Ross E. Brown, with comments and illustrations. 3500 w. Min & Sci Pr—July 30, 1898. No. 21931.

Sea-Water Gold.

The Electrolytic Marine-Salts Company. History of the company, with editorial comment, showing how readily the American public are humbugged. 2400 w. Eng & Min Jour—July 30, 1898. No. 21813.

Silver-Lead.

Experiments in the Sampling of Silver-Lead Bullion. G. M. Roberts. Report of interesting experiments made in sampling the silver-lead bullion obtained from the water-jacket smelting-furnace at the Proprietary Mines, Broken Hill, N. S. W., for the purpose of ascertaining the relative accuracy of the methods then in use. 3000 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22261 D.

Smelting.

Recent Advances in Silver-Lead Smelting. R. H. Terhune. Read at the Salt Lake session of the International Mining Congress. Reviews the improvements in recent years in silver-lead smelting. 2800 w. Min & Sci Pr—Aug. 6, 1898. No. 22040.

The Lang Smelting Furnace. Illustrates and describes a form of furnace recently patented. 1000 w. Eng & Min Jour—Aug. 6, 1898. No. 21981.

IRON AND STEEL.

Arctic Circle.

The Iron Ores of the Arctic Circle. Perry F. Nursey. In connection with the meeting of the Iron & Steel Inst., at Stockholm, an excursion is to be made to the arctic mines. Information concerning these deposits is given. 1800 w. Ind & Ir—Aug. 19, 1898. Serial. 1st part. No. 22410 A.

Blowing Engines.

See Mechanical Engineering, Engines.

Filling.

Note on the Forms Assumed by the Charge in the Blast-Furnace, as Affected by Various Methods of Filling. Frank Firmstone. Information accumulated from careful measurements in the furnace, afterwards recorded for comparison in drawings. Most of the measurements were made at Glendon Iron Works where the fuel used was anthracite, and the ore mixtures about ¾ New Jersey magnetic ores and ¼ brown ores. 3500 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22267 D.

Furnace.

See Electrical Engineering, Electro-chemistry.

Iron Manufacturing.

Iron Manufacturing at Marquette. Extracts from a report of John Birkinbine, made for J. M. Longyear. A masterly discussion of the advantages and disadvantages of Marquette for iron and steel manufacture. 10000 w. Ir Age—Aug. 4, 1898. No. 21909.

Ores.

American as Compared with British Iron Ores. Walter J. May. Extracts from the Report on the Mesabi Iron Range in Minnesota, by J. Edward Spurr; the ores are compared with English ores; methods of working are discussed, and related matters of interest treated. 2500 w. Prac Eng—Aug. 5, 1898. No. 22053 A.

Foreign Iron Ores at the Disposal of European Works. Circumstances relating largely to Great Britain's supply. The ores of Spain and Sweden are specially discussed. 2000 w. Ir Age—Aug. 18, 1898. No. 22106.

High-Grade Iron Ores. Walter J. May. Discusses the necessity of dealing with the deposits of low-grade ores and concentrating them at the mines to a high metallic value. 900 w. Col Guard—Aug. 12, 1898. No. 22164 A.

Steel Constituents.

The Constitution of Steel Considered as an Alloy of Iron and Carbon. Albert Sauveur. Briefly outlines the laws which govern frozen saline solutions, and showing how they help to account for the structure of metallic alloys. Ill. 6000 w. Tech Quar—June, 1898. No. 21-817 F.

Swedish Iron.

Strength Tests of Swedish Iron and Steel. Interesting tests published by the "Järnkontoret," giving table showing the percentages of carbon which have been proved suitable for various applications, and other information. 900 w. Engng—Aug. 19, 1898. No. 22295 A.

MINING.

Boreholes.

Tubed Cylinder Stemming for Boreholes. W. Wilson Barnes. Illustrates and describes methods of using these cylinders, and the success and advantages. 1200 w. Col Guard—July 22, 1898. No. 21832. A

Explosives.

Experiments with Safety Explosives. P. Hess. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Gives the code of regulations insuring uniformity in the methods of testieg with a summary of the results obtained. 1200 w. Col Guard—Aug. 5, 1898. No. 22067 A.

New Order as to the Use of Explosives in Coal Mines. A new order as to the use of explosives in British mines in substitution for the order dated Feb. 4, 1898. 900 w. Ir & Coal Trds Rev—July 22, 1898. No. 21849 A.

Firedamp.

Firedamp in Its Relation to Meteorology. Ernest Van den Broeck. From a communication to the Société Belge de Geologie de Pa'éontologie et d'Hydrologie. Remarks on the limited success in solving the problem of firedamp, and a project for making magnetic and endogenous observations to investigate the connection between the disengagement of underground gases and aërial storms. 2200 w. Col Guard—Aug. 12, 1898. No. 22163 A.

Mining Law.

The Providence-Champion Decision. R. W. Raymond. Discusses the parts of the case having a general application, and the decision rendered. 1600 w. Eng & Min Jour—Aug. 20, 1898. No. 22141.

Pit-Props.

The Strength of Pit-Props. H. Louis, in London *Mining Journal.* Records experiments made involving about 170 separate tests. 2200 w. N. Z. Mines Rec—July 16, 1898. No. 22424 B.

Pump.

See Electrical Engineering, Power.

Rescue Appliances.

New Rescue-Appliances and Their Use in Mines. M. L. Denoël, in the *Annales des Mines de Belgique.* Discusses the appliances, giving some reasons why they have not come into general use. 1800 w. Col Guard—Aug. 19, 1898. No. 22296 A.

Shaft Sinking.

Deepening and Strengthening the Oskar Shaft No. I. at Petrzkowitz, Preussen. (Abteufen und Ausmauerung des Oskar-Schachtes Nr. I bei Petrzkowitz in Preussen.) Describing the operation of sinking a shaft over 650 feet including lining with masonry. Valuable data are given as to time and cost in various strata. 5000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 30, 1898. No. 22349 B.

Sinking and Lining a Shaft at a Prussian Colliery. Jaroslav Jicinsky. *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Describes the sinking of the new Oskar shaft, 197 m. in depth. 1200 w. Col Guard—Aug. 12, 1898. No. 22165 A.

Underground Pumping.

Underground Steam Appliances and Temperature of the Strata. Robert Martin. Abstract of a paper read before the Mining Inst. of Scotland. Illustrates and describes the steam pumping system at Niddrie collieries. 1200 w. Col Guard—Aug. 19, 1898. No. 22297 A.

Winding Engines.

See Mechanical Engineering, Engines.

MISCELLANY.

Aluminum.

Aluminum Manufacture, with Description of the Rolling Mills and Foundry at Milton, Staffordshire. E. Ristori. Read before the Inst. of Mech. Engs. at Derby, England. Description and plan of the works where aluminum is melted and refined until it attains a purity of 99.6 per cent. The manner of working, the alloys, and uses, are considered. Also discussion. 7500 w. Engng—July 29, 1898. No. 21961 A.

The Present Status of the Aluminum Industry. (Der Heutige Stand der Aluminium Industrie.) Dr. B. Neumann. A review of the development of the industries since the introduction of the Deville process; with data as to the production of the American, Swiss, and French establishments at the present time by electrical methods. 2500 w. Glückauf—July 30, 1 No. 22354 B.

Bearing Metals.

The Microstructure of Bearing Metals. Guilliam H. Clamer. An interesting study of the structure and composition of the various bearing metals, especially those used in railroad service, has led to the conclusion that an alloy of the proper proportions of copper, tin and lead seems best suited for the purpose. Discussion. Ill. 5500 w. Jour Fr Inst—Aug., 1898. No. 21913 D.

Chinese Mines.

Chinese Salt and Gas Mines. An interesting account of the manner of working these mines, which have been uninteruptedly worked for over twenty centuries. 1500 w. Engr, Lond—Aug. 12, 1898. No. 21922 A.

Clays.

The Clays and Clay Industry of Massachusetts. Charles L. Whittle. Gives information of the workable beds of the state, and of the advancement of this industry. 2100 w. Eng & Min Jour—Aug. 27, 1898. No. 22256.

Corundum.

The Corundum Lands of Ontario. An account of the discovery and occurrence, with the conditions and regulations proposed by the Director of the Bureau of Mines to be adopted and followed in connection with the disposition of corundum-bearing lands. 3000 w. Can Min Rev—July, 1898. No. 21874 B.

Exposition.

The Trans-Mississippi International Exposition. A description of the mineral exhibits from the different states and territories represented in the mining building. 2500 w. Mines & Min—Aug., 1898. No. 21948 C.

Fuel.

A Popular Study of the Mineral Fuels of the World. (Volkswirthschaftliche Studie über die Mineralischen Brennstoffe der Erde.) Prof. F. Kupelureser. An exhaustive compilation, with valuable comments, the figures being tabulated for all countries from 1870 to 1896. Three articles. 15000 w. Zeitschr d Oesterr Ing u Arch Ver—July 8, 15, 22, 1898. No. 22316 each B.

New Methods.

Recent Improvements in Metallurgical Methods. (Neuerungen im Metallhüttenwesen.) Dr. Dürre. Brief descriptions of improvements in the metallurgy of aluminum, antimony, arsenic, lead, silver, gold, copper, nickel, zinc, and tin. 4500 w. Glückauf—July 16, 1898. No. 22352 B.

Petroleum.

The Baku Petroleum District of Russia. David A. Louis. A fully illustrated account of the Russian oil fields as seen at the time of the visit of the International Geological Congress. 3500 w. Engineering Magazine—September, 1898. No. 22388 B.

The Russian Petroleum Industry in 1897. (Die Russische Erdölindustrie im Jahre 1897.) A review of the progress of the Baku oil fields during the past year; monthly comparisons being made with the years 1895 and 1896. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 23, 1898. No. 22350 B.

Pit Gases.

Apparatus for Estimating Marsh Gas and Carbon Dioxide in Pit Gases. R. Jeller. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* An illustrated description of apparatus suitable for the requirements of practice, but not intended for use where the proportion of combustible gases gives rise to an explosive mixture. 1500 w. Col Guard—Aug. 5, 1898. No. 22063 A.

Transvaal.

The Mineral Resources of the Middelburg District (Transvaal). Herbert Lloyd. Read before the Manchester Geological Society. Describes the geology of the region, gives information relating to the coal deposits, and the rich mineralized districts. 1700 w. Col Guard—Aug. 19, 1898. No. 22298 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Accidents.

Accidents with Gas. William Paul Gerhard. Narrates various accidents and emphasizes the dangers arising from leakage. 2700 w. Am Arch—Aug. 6, 1898. No. 22000.

Acetylene.

The Criterion Automatic Acetylene House Generator. Illustrates and describes two styles of acetylene-gas generators, especially intended for lighting single dwelling houses, country seats and out buildings, small manufacturing plants, &c. 700 w. Sci Am—Aug. 6, 1898. No. 21917.

The Utilization of Acetylene. A review of the advantages and limitations of acetylene and a discussion of the position the calcium-carbide industry may hope to gain. 2500 w. Engr, Lond—Aug. 19, 1898. No. 22403 A.

Ammonia.

A Noteworthy Curiosity from the U. S. Patent Office. Frederick Egner. An explanation of what is known as the Fogarty process for producing gas and ammonia, by which the gas is merely a by-product made without cost. 2000 w. Am Gas Lgt Jour—Aug. 8, 1898. No. 21998.

See Mining and Metallurgy, Coke.

Calcium Carbide.

Development of the Carbide of Calcium Industry. Gives facts of scientific interest in connection with this product, its history, and the commercial importance of the industry. 4000 w. Sci Am Sup—Aug. 13, 1898. No. 22049.

The Manufacture of Calcium Carbide. Abstract of a paper read by M. Nicolai, at a meeting of the Polytechnical Society, at Berlin. Discusses the raw materials, important points in the manufacture, transportation, &c. 1600 w. Am Mfr & Ir Wld—Aug. 26, 1898. No. 22283.

The New Plant of the Union Carbide Company at Sault Ste. Marie, Mich. Illustrated description of the new equipment whose initial output is to be ten times that of Niagara, with capacity for extension as the demand increases. 1800 w. Elec Wld—Aug. 6, 1898. No. 21920.

Competition.

Gas in Competition with Electricity by Water Power. A. Gutsch. Read at meeting of the Pacific Coast Gas Assn. A statement of facts as they are found at Fresno, Cal. Also discussion. 3600 w. Am Gas Lgt Jour—Aug. 15, 1898. No. 22082.

Cowan System.

The "Cowan Pressure-System." J. Hepworth. Read at meeting of North British Assn. of Gas Managers. Notes on the object of this system, with short description of the apparatus. Discussion. 3800 w. Gas Wld—Aug. 6, 1898. No. 22075 A.

Explosions.

Note on Further Studies into the Phenomena of Gas Explosions. W. H. Birchmore. Describes experiments made to investigate the apparent antithesis between the wrecking and incendiary power of an explosion. 2400 w. Am Gas Lgt Jour—Aug. 1, 1898. No. 21879.

Lubrication.

Lubrication in the Gas Business. O. M. Gregory. Read at meeting of the Pacific Coast Gas Assn. Brief talk on the use of lubricants and kinds best suited to the gas business. 1800 w. Am Gas Lgt Jour—Aug. 15, 1898. No. 22083.

Mantles.

Thread Foundation for Incandescent Mantles. Illustrates a device for producing more durable and effective mantles. 500 w. Bos Jour of Com—Aug. 20, 1898. No. 22185.

Meters.

Experiences with Prepayment Meters. A. Wilson. Read at meeting of North British Assn. of Gas Managers. An account of the experiences in Perth, Scotland, where over 1100 are in use. Discussion. 2000 w. Gas Wld—Aug. 6, 1898. No. 22074 A.

My Experience with Prepayment Meters. R. Ross. Read before the North of Ireland Assn. of Gas Managers. Gives an account of the difficulties met, but reports satisfactory results. Discussion. 2800 w. Gas Wld—Aug. 13, 1898. No. 22170 A.

Oil Heater.

An Efficient Oil Heater. E. C. Jones. Read before the Pacific Coast Gas Assn. Illustrates and describes a heater which has successfully heated both crude oil and distillates for two 12-foot generators, making 1,000,000 feet of gas each per 24 hours, but running alternately. Discussion. 4800 w. Am Gas Lgt Jour—Aug. 22, 1898. No. 22198.

Purifying.

The Purifying of Coal Gas. Stephen Carpenter. Describes process of purification found more convenient and economical than any other in which lime is employed. 2000 w. Jour of Gas Lgt—Aug. 9, 1898. No. 22131 A.

Retorts.

Retort Settings and Practical Results Obtained. William Ewing. Read at meeting of North British Assn. of Gas Managers. Describes the works of the Hamilton Corporation (Scotland), the difficulties and means of overcoming them. Discussion. Ill. 5000 w. Gas Wd—July 30, 1898. No. 22012 A.

Self-Lighters.

Recent Progress in Self-Lighters for Incandescent Lamps. M. Syssoyeff. Read before the French Society. A review of the attempts made to solve this problem and report of the results obtained in lighting by chemical reaction. 2300 w. Gas Wld—July 23, 1898. No. 21864 A.

SEWERAGE.

Drainage.

See Architecture and Building, Plumbing.

Norwich, Eng.

Norwich Sewerage Works. Illustrates and describes a system that has been obliged to conquer many difficulties. 1500 w. Engr, Lond —July 22, 1898. No. 21841 A.

River Pollution.

Pollution of Rivers from an Engineer's Point of View. Reginald E. Middleton. Discusses the various sources of pollution and the means of purification. 2500 w. Jour of the San Inst—April, 1898. No. 21855 G.

Rivers-Pollution Standards. W. Naylor. Discusses standards suggested, and their applicability, urging the necessity of a uniform standard and method of analysis. Discussion. 5400 w. Jour of San Inst—April, 1898. No. 21857 G.

Sewage Conveyance.

The Old and the New. Alexander Dalrymple. Read at the opening of the tenth session of the Glasgow and West of Scotland Technical College. Deals with fittings for bathrooms. 3000 w. Dom Engng—Aug., 1898. Serial. 1st part. No. 22101 C.

Sewage Disposal.

Bacterial Processes of Sewage Purification. Rudolph Hering. A review of the latest developments in sewage purification by bacterial processes, with descriptions and illustrations of the works at Exeter, Sutton, and Yeovil. 4500 w. Engineering Magazine—September, 1898. No. 22386 B.

London Sewage Disposal. James H. Fuertes. Description of methods and results at two large chemical-treatment plants. 1200 w. Eng Rec—Aug. 27, 1898. Serial. 1st part. No. 22276.

Massachusetts Experiments on the Purification of Fresh, Stale, and Septic Sewage. H. W. Clark. A brief review of the work at the Lawrence experiment station, and results of investigations recently made. 5800 w. Eng News—Aug. 4, 1898. No. 21944.

The Disposal of Sewage in Tidal Estuaries. G. Sims Woodhead. Points out the different conditions in some large tidal rivers, and discusses what is necessary in order that purification may take place. Also discussion. 3500 w. Jour of San Inst—April, 1898. No. 21854 G.

The Purification of Sewage by the Ferozone Polarite System. John W. Alvord. Description of the original works at Acton, Eng., where this chemical system is in use, with account of the operation and efficiency. Discussion. 7500 w. Ill. Soc of Engs & Surv—1898. No. 22210 D.

Sewers.

Injuries to Sewers by Roots. Description of the construction of pipe sewers in Washington to prevent this trouble. 2500 w. Eng Rec—Aug. 20, 1898. No. 22193.

The New Sewer System of Chicago. A brief account of the extensive work in progress and its cost, with a statement of the conditions which led to the undertaking. Ill. 2000 w. Engr, Lond—July 22, 1898. No. 21839 A.

Trade Waste.

Conditions for the Preliminary Treatment of Trade-Waste Water before its Admission into Public Sewers. H. Maclean Wilson. A statement of the conditions that should be required before such liquids are received into the public sewers. Discussion. 3500 w. Jour of the San Inst—April, 1898. No. 21856 G.

STREETS AND PAVEMENTS.

Asphalt.

Minor Repairs to Asphalt Pavements. F. E. Puffer. The object of the article is to show how minor repairs to asphalt pavements may be made in an economical and substantial manner without the use of a large asphalt plant. 500 w. Munic Engng—Aug., 1898. No. 21867 C.

Wood Pavements.

The Sanitary Aspects of Wood Pavements. Charles Mason. Brief reference to the kinds of wood employed, their treatment and method of laying, with discussion of the sanitary conditions, showing that the writer considers complaints of this pavement to be due to improper methods of laying and maintaining, with faulty systems of scavenging. 1500 w. Jour of San Inst—April, 1898. No. 21860 G.

WATER SUPPLY.

Distribution.

Test of a Pipe Distribution System. James S. Haring. Description of method of detecting defective pipes, valves, and hydrants, with an account of unusual failures of valves. 1700 w. Eng Rec—July 30, 1898. No. 21809.

Domestic Supplies.

The Purification of Domestic Water Supplies. H. T. Y. Outlines a plan to heat water to a temperature of 230° Fahr. for seven minutes under pressure, before it enters the mains for distribution. 1000 w. San Rec—July 22, 1898. No. 21824 A.

Early Plants.

Early Water-Works Plants. Extracts from a paper by William R. Hill presented at the Buffalo meeting of the Am. Water-Works Assn. Interesting historical review of skill in obtaining water. 1600 w. Fire & Water—Aug. 6, 1898. Serial. 2 parts. No. 21929.

Filtration.

The Filtration of Water in Germany. M. L. Holman. Describes German practice in filtration, giving only those features which pertain directly to construction and operation. Discussion. Ill. 10500 w. Jour Assn of Engng Soc's—July, 1898. No. 22217 C.

The Somersworth, N. H., Sand Filters. Illustrated description of covered sand-filters of half-an-acre effective area. 1100 w. Eng Rec—Aug. 27, 1898. No. 22273.

Glasgow.

Glasgow Water Works. James H. Fuertes.

An account of the water supply and the construction of the new reservoir, work on which has been in progress for 13 years, with the general plan of the works. 1200 w. Eng Rec—Aug. 6, 1898. No. 21988.

Intakes.

The Intakes of the Great Lakes. Thomas W. Barrally. From a paper read before the Mich. Engng. Soc. Describes various intakes on the Great Lakes and the difficulties met with, favoring the submerged type. 1800 w. Ry & Engng Rev—Aug. 6, 1898. No. 21992.

The New Water-Works Intake Tunnel for Cleveland, Ohio. A description, with illustrations, of the new tunnel and accessories, with brief reference to the old works. This is supposed to be the longest water-works intake tunnel yet attempted. 6700 w. Eng News—Aug. 11, 1898. No. 22045.

Legal Decision.

Two Recent Legal Decisions Concerning the Sale of Water. Reviews decisions in Kansas and California affecting the business of water companies. 800 w. Eng Rec—Aug. 13, 1898. No. 22091.

Meters.

Calibration of a Water Meter. William D. Ennis. Describes a form of apparatus, built by the writer for experimenting with meters and an account of experiments made. 1200 w. Stevens Ind—July, 1898. No. 21853 D.

Montauk Point.

The Water at Montauk Point Camp. Brief account of the state of the water supply, reporting the quantity plentiful at present, but some doubts are expressed of its permanence. 800 w. Fire & Water—Aug. 20, 1898. No. 22148.

Pollution.

The Local Government Board and the Protection of Water Supplies from Pollution. Percy Griffith. Deals with the clauses bearing on this matter, which the Board endeavored recently to introduce into Private Bills which were before the Houses of Parliament, summing the actual condition of affairs at the present time. 3400 w. Jour of Gas Lgt—Aug. 9, 1898. Serial. 1st part. No. 22132 A.

The Prevention of the Pollution of Water Supplies. Review of decision of New York Supreme Court permitting acquisition of land bordering reservoirs to prevent pollution. 1000 w. Eng Rec—Aug. 20, 1898. No. 22189.

Portland, Ore.

Portland's Perfect Water System. Brief account of the receipts from the municipal plant, with description. 800 w. Fire & Water—Aug. 27, 1898. No. 22288.

Pump House.

New Pump-House at Richmond, Va. Illustrated description of this recent improvement, and the system generally. 900 w. Fire & Water—Aug. 20, 1898. No. 22147.

Pumping.

Deep-Well Pumping. E. E. Johnson. Considers the subject of deep-well water-supply, and various types of pumps, with illustrated description of a continuous-flow deep-well pump, giving tests of plants where it is used. Discussion. 9000 w. Ill Soc of Engs & Surv—1898. No. 22211 D.

Pure Water.

Chemistry of Water Supply. A. W. Palmer. From a sanitary standpoint water which may continuously be used for drinking without deleterious effects is regarded as pure. An explanation of data obtained by analysis is given. Discussion. 7500 w. Ill Soc of Engs & Surveyors—1898. No 22209 D.

Purification.

Bacterial Reduction by Storage. Review of important investigations showing that the bacterial purification of the river-water supplies of London depends largely on storage. 2000 w. Eng Rec—Aug. 15, 1898. No. 22094.

Purification of Water for Barracks, Prisons, and other Institutions. J. Lane Notter. Discusses various methods of filtration, and other means of rendering water sterile. Discussion. 8500 w. Jour of San Inst—July, 1898. No. 21861 G.

Rates.

The Equity of the Detroit Water Rates. Reprint of decision of Michigan Supreme Court, upholding the right of the city's commissioners to collect the rates in force in 1890. A unique case. 3300 w. Eng Rec—Aug. 27, 1898. No. 22274.

Water Rates in Milwaukee. Editorial on objections to charging a uniform rate for large and small supplies. 1200 w. Eng Rec—July 30, 1898. No. 21805.

Reservoirs.

Compensating Reservoirs for Gravity Water Supplies in Lieu of Compensation for Riparian Rights and its Legal Aspects. Stephen E. Babcock. Read at the convention of the Am. Water-Works Assn. Discusses the ownership of excess flow of water, showing that without infringing on the rights of owners of land, this may be retained and used for water supply. 4000 w. Fire & Water—Aug. 20, 1898. No. 22146.

Standpipe.

Racine's Standpipe and Its Brick Casing. Describes this standpipe and its location, explaining the reasons for encasing it, and giving the specifications for the work. Ill. 3000 w. Fire & Water—Aug. 27, 1898. No. 22287.

State Supervision.

Proposed State Supervision of Water Supply and Sewage Disposal. Jacob A. Harmon. A brief review of work being accomplished under supervision of the Boards of Health of states where authority exists. Discussion. 8000 w. Ill Soc of Engs & Surv—1898. No. 22214 D.

Supply.

Furnishing Water. William Himrod. Read at the Buffalo meeting of the Am. Water Works Assn. Some of the experiences of the water commissioners with their customers, giving an account of system of conducting the water business in Erie, Penna. 3300 w. Fire & Water—Aug. 6, 1898. No. 21928.

Waste.

Water-Supply Waste in India. The difficulties arising from an attempt to manage an alien people in the same manner that obtains among those whose education and conditions are very different. Considers the principle that should be followed in supplying water to consumers. 1100 w. Ind Engng—July 23, 1898. No. 22220 D.

Water Pollution.

Water-Borne Typhoid Fever. Christopher Childs. A paper introducing a discussion of this subject, and chiefly considering the means by which this pollution may be prevented. Discussion follows. 9500 w. Jour of San Inst—July, 1898. No. 21862 G.

Watersheds.

The Desirability of Making Watershed Areas and Sanitary Districts Coterminous. R. E. Middleton. Shows that the changed conditions of life, especially in England, have greatly increased the tendency to pollute rivers; that the growth of cities and towns has made the water supply more limited, yet increased the demand; and discusses the policy necessary if the water supply is to be efficiently safe-guarded. General discussion. 7500 w. Jour of San Inst—July, 1898. No. 21863 G.

Water-Works.

Anabaena. Report of investigation of the source of the odors imparted by anabaena to water supplies. 500 w. Eng Rec—Aug. 27, 1898. No. 22270.

Wells.

What Is a Test of a Well? A discussion of legal difficulties due to faulty specifications; the case of Bennett v. Edison Electric Illuminating Co. 900 w. Eng Rec—Aug. 6, 1898. No. 21984.

MISCELLANY.

Detroit.

Detroit: An Interesting City. A finely-illustrated article describing the interesting features of the city and its municipal affairs. 3800 w. Munic Engng—Aug., 1898. No. 21866 C.

Garbage.

Garbage Disposal at Detroit. An interesting description of the reduction process taken from the annual report of Dr. Walter Kempster of Milwaukee, a delegation of officials having visited the plant. 900 w. Eng Rec—Aug. 6, 1898. No. 21986.

The Barren Island Garbage-Disposal Plant. Olin H. Landreth. Report on the remodeled plant reducing the garbage of Manhattan and Brooklyn, New York City. 1500 w. Eng Rec—Aug. 27, 1898. No. 22277.

Refuse.

Refuse Disposal in Edinburgh. Editorial review of the methods and expense in this city, showing that this problem must be solved for each city independently. 800 w. Eng Rec—Aug. 6, 1898. No. 21983.

The Horsfall Destructor. Illustrates and describes the destructors at Bradford, Eng., which have several improvements of interest. 2500 w. Engng—Aug. 12, 1898. No. 22158 A.

Sanitation.

The Outcome of Sanitation. Louis C. Parkes. A record of the progress during the reign of Queen Victoria. 6500 w. Jour of San Inst—April, 1898. No. 21890 G.

See Architecture and Building, Plumbing.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Three Months' Railway Accidents. From the British Board of Trade Returns of Accidents and Casualties. Shows a decrease in the numbers of killed and injured as compared with last year. 900 w. Transport—Aug. 19, 1898. No. 22414 A.

Live Stock.

The Transit of Live Stock on Railways. Discusses the poor accommodations for the transportation of animals in Great Britain and Ireland, with the recommendations of the Departmental Committee of the Board of Agriculture. 1500 w. Transport—July 22, 1898. No. 21821 A.

Private Lines.

The Relation of Private Car Lines to the Railroads. G. W. Showers. Read at meeting of the Car Foremen's Assn. of Chicago. Reviews the early conditions of railroading and the work of the private car lines. 3800 w. Ry Mas Mech—Aug., 1898. No. 21997.

Train Service.

The Summer Train Improvements. Editorial comment on the train service of Great Britain. 2000 w. Engng—Aug. 19, 1898. No. 22292 A.

Train Speeds.

A New American Railway Record. Charles Rous Marten. English comments on the speed attained by the fast trains between Philadelphia and Atlantic City. 800 w. Engr, Lond—Aug. 5, 1898. No. 22061 A.

On the Fastest Train in the World. A. S. Describes a ride on the train that runs from Camden to Atlantic City, a distance of 55.5 miles in 50 minutes. 1200 w. Loc Engng—Aug, 1898. No. 21882 C.

Record-Breaking Railway Runs. List of 125 of the most notable runs made in Great Britain and America with remarks. 1800 w. Ry Age—July 29, 1898. No. 21872.

FINANCIAL.

American Railroads.

The Country's Railroads. Some remarks on the statistics for the year ending June 30, 1897, which show how the railroads suffered from the

effects of the disturbance of credit and shrinkage of business during that trying year. 800 w. Bradstreet's—Aug. 27, 1898. No. 22246.

Earnings.

July Railroad Earnings Show Small Gains. A report of the July earnings, with comparison of corresponding mileage for previous year. 2500 w. Bradstreet's—Aug. 13, 1898. No. 22050.

Net Railway Earnings Well Maintained. Reports the first half of the present year as highly satisfactory and gives comparative tables. 1200 w. Bradstreet's—Aug. 20, 1898. No. 22137.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Specifications for Air-Brake Hose. G. P. Campbell. Discusses some of the causes of failure in air hose, showing that they are not due to poor material. 1500 w. R R Gaz—Aug. 26, 1898. No. 22249.

Car Ferry.

The Car Ferry Boat "Pere Marquette." Illustrated description of a boat built expressly for this route between Ludington, Mich., and Manitowoc, Wis. 500 w. Ry & Engng Rev—July 30, 1898. No. 21875.

Car Gates.

Gates on Cars. George De Haven. Extracts from an address before a meeting of travelling men at Grand Rapids, Mich., with editorial. Explains the operation and states the advantages. 4300 w. Ry & Engng Rev—Aug. 13, 1898. No. 22086.

Flat Car.

Lehigh Valley Flat Car; 110,000-Pounds Capacity. Illustrated description of a car built in 1887 from the designs of John S. Lentz. 700 w. R R Car Jour—Aug., 1898. No. 21975.

Locomotives.

A New Locomotive Cylinder. A description of the cylinder arrangement invented by W. F. and E. W. Cleveland, now on trial on the Intercolonial Railway of Canada. Also editorial. 900 w. RR Gaz—Aug. 5, 1898. No. 21924.

Best Form of Fastenings for Locomotive Cylinders. From a report presented at the 1898 convention of the Am. Ry. Master Mechs. Assn. Ill. 2500 w. Ry & Engng Rev—July 30, 1898. No. 21876.

Class G-6 Consolidation Locomotive for the Chesapeake & Ohio. Engravings, description and dimensions. 900 w. RR Gaz—Aug. 5, 1898. No. 21923.

Darjeeling-Himalayan Railway Locomotives. Illustrated description of engines employed in climbing steep grades, and taking sharp curves. 800 w. Ind Engng—July 16, 1898. No. 22138 D.

Heavy Passenger Locomotive, Baltimore & Ohio Railway. Drawings of the ten-wheel locomotives in use, with data regarding the work they are doing. 600 w. Ry & Engng Rev—Aug. 13, 1898. No. 22087.

Tank Capacity of Large Freight Locomotives. Editorial on the water requirements of heavy freight locomotives. 900 w. R R Gaz—Aug. 12, 1898. No. 22038.

Tests of a Baldwin Locomotive on the Louisville and Nashville. An account of interesting service tests made by members of the graduating class of Rose Polytechnic Inst., under the direction of F. C. Wagner. 2000 w. R R Gaz—Aug. 12, 1898. No. 22036.

The Future Development of the Locomotive. Maurice Demoulin. From the Bulletin of the International Railway Congress. Discusses to what extent engines can be made more powerful and less heavy, the present tendencies and the types likely to be developed. 2600 w. R R Gaz—Aug. 12, 1898. No. 22034.

Mountain Roads.

Note on the Swiss Funicular Railways. (Note sur les Chemins der Fer Funiculaires Suisses.) General description, with very complete table of the Swiss cable roads for ascending steep mountain inclines. 1800 w. La Revue Technique—July 25, 1898. No. 22330 D.

Private Car.

Private Car; Florida East Coast Railway. Illustrated description of the luxurious car built for H. M. Flagler, president of the road named. 500 w. R R Car Jour—Aug., 1898. No. 21977.

Pullman Exhibit.

The Pullman Exhibit at the Omaha Exposition. Duane Doty. Brief descriptions of the five handsome cars; a smoking car, sleeper, dining car, observation car and parlor car. 1200 w. R R Car Jour—Aug., 1898. No. 21976.

Repairs.

Best Methods of Locating and Repairing Defects en Route. Abstract of report to Assn. of RR Air Brakemen. Gives list of defects usually found and suggests remedies. 2800 w. R R Car Jour—Aug., 1898. No. 21978.

Differential Prices for Repairs. An examination of the underlying principles claiming to show the fallacy of the claims for differential rates under the M. C. B. rules. 1400 w. R R Car Jour—Aug., 1898. No. 21974.

Train Resistances.

Train Resistances on Straight and Curved Tracks. Frank C. Wagner. From a paper presented at the Boston meeting of the Assn. for the Advancement of Science. Explains manner of obtaining data and the results. 800 w. R R Gaz—Aug. 26, 1898. No. 22251.

Trucks.

Standard Trucks. E. D. Bronner. Discussion of the merits of diamond and steel-plate types, before the M.C.B. convention, June, 1898. 1400 w. Eng & R R Jour—Aug., 1898. No. 21877 C.

Works.

The Canadian Pacific Shops—Car Department. Brief description of the workshops, and illustrated description of work now receiving special attention. 2000 w. R R Gaz—Aug. 19, 1898. No. 22126.

The Horwich Shops of the Lancashire & Yorkshire Railway. F. J. M. Illustrated detailed description of English shops of unusual interest. 3200 w. Am Mach—Aug. 25, 1898. Serial. 1st part. No. 22223.

The Midland Railway Locomotive Works.

An illustrated description of these important English works at Derby, and the tools in use, with related matter of interest. 5400 w. Engng—July 22, 1898. No. 21845 A.

NEW PROJECTS.

Alaska.

Railway Construction in Alaska. Particulars relating to this work with views and map. 1500 w. Ry & Eng'ng Rev—Aug. 27, 1898. No. 22280.

Ceylon.

The Railways of Ceylon: The Broad and Narrow-Gauge Problem. An interesting illustrated account of these railways, which are very picturesque, with explanation of the slow progress made in railway building. 3000 w. Engr, Lond—Aug. 19, 1898. No. 22406 A.

Chile.

Automatic Inclines and Railway, Junin, Chile. Josiah Harding. Communicated to the British Inst. of Civ. Engs. Describes a railway constructed to connect the nitrate beds, which are generally about 1000 meters above the sea-level, with the coast. 2400 w. Col Guard—Aug. 19, 1898. No. 22299 A.

China.

Railway Enterprises in China. Translations of articles from Chinese papers in regard to the construction of railroads. 1500 w. Cons Repts—Aug., 1898. No. 22081 D.

Congo.

The Congo Railway. An interesting illustrated account of the construction and the difficulties encountered. Also describes the equipment, service, and related matters. 2500 w. Engr, Lond—July 29, 1898. No. 21969 A.

Jungfrau.

The Jungfrau Railway. Edgar R. Dawson. Describes and illustrates the railway being constructed to the top of this mountain whose altitude is 13,720 feet. 2500 w. Scribner's Mag—Sept., 1898. No. 22177 C.

Mexico.

Railroad Construction in Mexico. L. P. Atwood. An account of work given in charge of the writer. 2000 w. Ill Soc of Engs & Surv—1898. No. 22213 D.

South Africa.

Railroad Building in South Africa. Sketch showing existing railroads, and roads now being built as far north as Kimberly and Bloemfontein, with some particulars regarding the work in progress. 1000 w. R R Gaz—Aug. 19, 1898. No. 22128.

PERMANENT WAY, BUILDING AND FIXTURES.

France.

French Railways and their Work. Charles Rous-Marten. A record of the work done on the Le Chemin de Fer du Nord in their express service, with description of the engines and road. 3800 w. Engr, Lond—July 22, 1898. Serial. 1st part. No. 21835 A.

Improvements.

Readville, Dedham, and West Roxbury Improvements. An illustrated account of the abolition of grade crossings, with changes in highways and station facilities, near Boston. 2500 w. R R Gaz—Aug. 12, 1898. No. 22035.

Narrow Gauge.

Narrow-Gauge Railways, Two Feet and Under. Leslie S. Robertson. Read before the Inst. of Mech. Engs. at Derby, England. Considers the reasons for adoption, advantages and disadvantages, various examples of this class, the equipment, &c. Also discussion. 6000 w. Engng—July 29, 1898. No. 21962 A.

Organization.

A Change in Maintenance of Way Organization. Editorial on the change taking place in the management of the Lehigh Valley Railroad. Does not think the step the correct solution of the problem. 1600 w. Ry & Engng Rev—Aug. 20, 1898. No. 22150.

Railway Bridges.

See Civil Engineering, Bridges.

Railway Widening.

Widening of the Midland Railway at Kentish Town. Illustrations with description of important work on an English railway. 2500 w. Engr, Lond—July 22, 1898. No. 21836 A.

Signals.

The Arrangement of Electric Distance Signals in a Block System. (Ueber die Einreihung Elektrischer Distanzsignale in Blocklinien.) Martin Boda. An illustrated description of the signal system used on the Austrian railways, in which an electrical distant signal is used in addition to the usual semaphore. 2500 w. Zeitschr d Oersterr Ing u Arch Ver—July 8, 1898. No. 22317 B.

The "Bootjack" Signals of the Lake Shore and Michigan Southern Ry. Illustrates and describes a peculiar signal in use on the L. S. & M. S. Ry. 900 w. Eng News—Aug. 4, 1898. No. 21939.

The Distinguishing Signal System of Single-Track Blocking. R. J. Hewett. Part first describes a system invented by the writer, capable of indicating the direction of train movement. 1800 w. Ry & Engng Rev—Aug. 13, 1898. Serial. 1st part. No. 22085.

Spanish Railways.

Spanish Railway Property. Gives a far from favorable account of the present condition. 1300 w. Engng—July 22, 1898. No. 21846 A.

Stations.

A New Station at Nashville. Brief illustrated description of an imposing structure to be erected. 400 w. Ry Age—Aug. 19, 1898. No. 22196.

New C. B. & Q. Passenger Station at Creston, Iowa. Engraving and plans of the building which is to cost about $50,000. 700 w. Ry & Engng Rev—Aug. 20, 1898. No. 22149.

Providence Passenger Station. An illustrated description of the train shed, now nearly completed, which has been the point of dispute between the railroad company and the officers of

the city. 600 w. R R Gaz—Aug. 5, 1898. No. 21925.

Steel Ties.

Steel Ties on the Netherlands State Railways; 1881 to 1898. Abstract of report prepared by the resident engineer, Ch. Renson, on the general results of careful observations for 17 years, giving interesting and instructive information. 2400 w. Eng News—Aug. 25, 1898. No. 22228.

Strengthening.

The Necessary Strengthening of the Permanent Way of our Railways. (Die Nothwendige Verstärkung des Oberbaues unserer Eisenbahnen.) Dr. Vietor. A paper showing the increasing traffic upon the German roads and a comparison with the railways of other countries in respect of increase of strength. 4500 w. Stahl und Eisen—August 1, 1898. No. 22356 D.

Switzerland.

The Schaffhausen-Eglisan and Thalweil-Zug Railways. (Mittheilungen über den Bau der Linien Schaffhausen-Eglisan und Thalweil-Zug.) An interesting descriptive account, with maps, profiles and details of viaducts and tunnels; giving an excellent idea of railway construction in Switzerland. Four articles, 5000 w. Schweizerische Bauzeitung—July 9, 16, 30, Aug. 6, 1898. No. 22362 each B.

Track Elevation.

Track Elevation in Chicago. Illustrates and describes interesting features in the progress of the work of eliminating grade crossings at Sixteenth Street. 1000 w. Ry Age—July 29, 1898. No. 21873.

Track Elevation of the Erie R. R. through Jersey City, N. J. Illustrates and describes a proposed plan for elevating tracks, and building a new passenger line in open cut across Jersey City Heights, thus avoiding the passage through Bergen tunnel. 900 w. Eng News—Aug. 18, 1898. No. 22125.

Train Resistances.

See Motive Power and Equipment.

Washout.

Railway Washouts. (Ueber Hochwasser-Katastrophen der Eisenbahnen.) A. Lernet. With especial reference to disasters occurring in Austria in 1896, with illustrations of temporary bridge, and protection to embankments. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—July 22, 1898. No. 22320 B.

Welding.

See Street and Electric Tramways.

TRAFFIC.

Fares.

Railway Passenger Fares and the Cost of Transportation. (Selbstkosten und Tarifsysteme der Eisenbahnen.) H. Klett. A comparison of the zone system with the distance system as operated in Hungary and Germany. 3000 w. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22310 D.

Greater London.

Greater London Railways. Report of the returns for the first half of this year of the Metropolitan and the Metropolitan District railways, showing growth of traffic. 1200 w. Engng—Aug. 12, 1898. No. 22157 A.

STREET AND ELECTRIC TRAMWAYS.

Alternating Currents.

The Application of Alternating Currents to Electric Traction. C. H. Davis and H. C. Forbes. A completion of the article in the August issue, especially comparing the advantages of local power stations and distant natural sources. 4000 w. Engineering Magazine—September, 1898. No. 22387 B.

Boston Subway.

The Boston Subway. Brief illustrated description. 1000 w. St Ry Rev—Aug. 15, 1898. No. 22285 C.

Boston Tramways.

The Boston Elevated Railway Company. Reviews the history of street-railroading in Boston, which is considered to have one of the finest systems in the country. Ill. 11500 w. St Ry Rev—Aug. 15, 1898. No. 22284 C.

Copenhagen, Den.

Fares and Earnings of the Copenhagen Tramways. V. Faber-Madsen. An account of the conditions prevailing in Copenhagen, where the average fare paid is 2.67 cents, with information concerning wages paid, cost of operation, &c. 5000 w. St Ry Jour—Aug., 1898. No. 21898 D.

Electric Railways.

The Electric-Railway Systems of Springfield and Holyoke, Mass. Illustrated detailed descriptions of the systems of the two cities named and their equipment. 3300 w. St Ry Jour—Aug., 1898. No. 21897 D.

Paris.

Electric Traction in Paris. L. Bayly. Brief illustrated description of the Madeleine-Courbevoie line, the cars being operated by the accumulator system. 1200 w. Elec Rev, N. Y.—Aug. 17, 1898. No. 22098.

Power.

Power Necessary to Keep Tramway Cars in Motion. Describes the method of computing the horse power. 1200 w. Ry Wld—Aug. 4, 1898. No. 22154 A.

Power Consumption.

Power Consumption in Electric Railroading. S. T. Dodd. Read before the Civil Engs.' Club of Cleveland, O. Part first is mainly devoted to the consideration of frictional resistance. 900 w. Elec Eng, N. Y.—Aug. 18, 1898. No. 22105.

Projects and New Construction.

Cork Electric Tramways. Beverley Griffin.

Read at meeting of the Municipal and County Engs., Cork. Illustrated description of plant. 1600 w. Elec Eng, Lond—Aug. 12, 1898. No. 22178 A.

Middlesborough, Stockton, and Thornby Electric Tramways. A finely-illustrated description of an English inter-urban street railway constructed by the Imperial Tramways Company on Tees-side. 5500 w. Ry Wld—Aug. 4, 1898. No. 22153 A.

The McGurty High-Speed Electric System for Mail and Express Service. Illustrates and describes the system. 800 w. Elec Eng, N.Y. —Aug. 25, 1898. No. 22208.

The Blackpool and Fleetwood Electric Tramways. Brief illustrated description. 1400 w. Elec Rev, Lond—July 22, 1898. No. 21815 A.

The Bradford Electric Tramways. Illustrated detailed description of an English municipal tramway. 1300 w. Elec Rev, Lond—July 29, 1898. No. 22011 A.

The Chicago and Milwaukee Electric Railway. A brief description of this suburban or inter-urban line, a portion of which was recently opened for traffic. 2300 w. Elec Rev, N. Y. —Aug. 24, 1898. No. 22202.

Speeds.

Tramway Speeds. M. H. Geron. A report presented to the Union Internationale Permanent de Tramways. Data from various countries operating lines either by steam, horses, compressed air, electricity, and a combination of these methods. 3800 w. Ry Wld—Aug. 4, 1898. No. 22155 A.

Tracks.

Recent Track Construction of the Sioux City Traction Company. Chester P. Wilson. Extracts from the specifications showing details of construction, with explanatory notes. Ill. 2500 w. St Ry Jour—Aug., 1898. No. 21899 D.

Underground.

The Underground Railways of London. Frederick E. Cooper. A very fully illustrated account of the underground railways of the metropolis, from the first undertakings to the latest projects. 6000 w. Engineering Magazine—September, 1898. No. 22384 B.

Walker System.

The Walker Conduit Electric Street-Railway System. Describes the most recent improvements in this system which has worked so successfully in New York and Washington. Ill. 900 w. Eng News—Aug. 4, 1898. No. 21,942.

Welding.

Electric Welding of Street-Railway Rails. Gives an account of the experience with welded joints in 1893, reports experiments, tests since made, and describes the work being done on the Nassau Ry. of Brooklyn. Ill. 1600 w. Eng News—Aug. 4, 1898. No. 21946.

BOOKS OF THE MONTH

THE STORAGE BATTERY, A Practical Treatise on the Construction, Theory and Use of Secondary Batteries. By Augustus Treadwell, Jr., E. E. London: Macmillan & Co., Limited. New York: The Macmillan Company. 1898.

It is hard to see how a more comprehensive or intelligible book could have been written on so highly specialized a subject. From an examination of its pages we are convinced that it will be of use, not only to the man who is engaged in the constant employment of storage batteries, but to those others who, not so well acquainted with the art, may find it necessary to investigate its economies and applications.

Nor will its service end here. Because of the wide field which he must cover, the engineer-at-large is inhibited from knowing the progress in every branch of his profession at the time it takes place, but by such careful condensations as are represented by this book, he who reads may with great facility, follow and understand what is being done in cognate subjects.

The author begins with a general account of the different cells and their contents. Next he describes the processes of manufacture of the "lead-sulphuric-acid" genus which is succeeded by a chapter on the prevention of buckling and the preparation of active material. This is followed by a relation of the methods involved in the preparation of the "lead-copper," the "lead-zinc," the "alkaline-zincate" and other miscellaneous types of cells. About thirty pages are then given to an extremely clear discussion of the theory.

Chapter VII is entitled Applications, and contains short but ample account of many installations in various cities of Europe and America.

A special chapter is devoted to the applications of accumulators to electric traction in which the author confirms the general impression that no tangible success has attended their use in that field in the United States, although (to quote his words): "In Europe . . . accumulator traction has a decidedly better outlook."

This is followed by a thorough review of the whole subject which includes some suggestions as to the probable course of future improvements.

The book is quite fully illustrated with drawings of the different cells and their parts, resistance and discharge curve-diagrams, plans of installations and half-tone reproductions.

Methods of measuring the internal resistance and the E. M. F. are given in an appendix which concludes with a tabulated list of a large number of batteries, showing what they are intended for, what the containing-cell is composed of, their efficiency, rate of discharge, etc.

A SHORT COURSE IN INORGANIC QUALITATIVE ANALYSIS: FOR ENGINEERING STUDENTS. By J. S. C. Wells, Ph. D. Instructor in Analytical Chemistry, Columbia University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. 1898.

Dr. Wells has succeeded in his avowed object, which is, without departing from the familiar plan of Fresenius, to make his treatise as concise as possible. He makes a most commendable effort also to avoid mere mechanical work on the part of the student by impressing the purpose of every use of a reagent, and this end is well aided by the tables of reactions, which accompany, in parallel, each scheme for group separations. It would seem as if, in the introductory chapters, the explanation of the writing of reactions might precede, more logically than follow, their use in discussing chemical changes, and that the definition of bases and acids should be introduced prior to the frequent use of the terms in defining the groups. But these matters should all be familiar to the student before he enters the laboratory; in introducing them into the manual, Dr. Wells doubtless only seeks to remedy a too frequent deficiency in the students coming under his charge.